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Timing and Conditions of Metamorphism in the Cascades Crystalline Core from Garnet Lu-Hf and Sm-Nd Geochronology

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By

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ABSTRACT

The Chiwaukum Schist and Tonga Formation of Cascades Crystalline Core experienced three distinct metamorphic events: (M1) an early metamorphism that predates regional pluton emplacement, (M2) low-pressure contact metamorphism in the aureoles of the Mount Stuart batholith and Beckler Peak pluton, and (M3) regional Barrovian metamorphism. The timing of these distinct metamorphic events is critical to testing models for the tectonic evolution of the region and mechanisms that lead to burial of rocks within the orogen.

I present new garnet Lu-Hf and Sm-Nd isochrons, average pressure and temperature calculations, and pseudosection modeling from the Chiwaukum Schist and Tonga Formation in order to constrain the timing and conditions of M1-M3 metamorphism in the Cascades Crystalline Core. Garnet Lu-Hf and Sm-Nd isochrons obtained from the Chiwaukum Schist in Icicle Canyon record the age of M1 metamorphism approximately 130 to 110 Ma at ~3 kilobar and ~650°C. The Lu-Hf isochrons, however, are scattered and likely reflect a complex polymetamorphic history. In the contact aureole of the Mount Stuart batholith, Lu-Hf and Sm-Nd isochrons date syn to post-M2 garnet growth in the Chiwaukum Schist between 95 and 90 Ma following batholith emplacement at 3.5 kilobar and ~550°C. Garnet growth during the regional M3 Barrovian overprint lasted from 91-86 Ma at 6-7.4 kilobar and~650°C, dates that are similar to published ages. In the Tonga Formation, a Lu-Hf age dates M1 garnet growth around 119 Ma at 3-4 kilobar and ~550°C, however, a second Lu-Hf sample is scattered and likely reflects a complex polymetamorphic history. Garnet Sm-Nd ages of 91 and 88 Ma from the same samples reflect M3 related cooling after intrusion of the Beckler Peak pluton and Excelsior Ridge orthogneiss at 6-7 kilobar and ~600°C.

The ages document the timing of M1 metamorphism in both the Chiwaukum Schist and Tonga Formation approximately 120-110 Ma, as well as Barrovian metamorphism in both regions starting at 91 Ma. M2 and M3 ages from both regions reflect a period of continual metamorphism and progressive burial beginning with the intrusion of the Mount Stuart batholith and satellite plutons between 96 and 92 Ma at 3-4 kilobar and culminating with rapid burial and continued deep seated magmatism through 88 Ma to pressures in excess of 6-8 kilobar. The results support correlations between the Chiwaukum Schist and Tonga Formation and provide new constraints on the timing and conditions of metamorphism.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Rare exposures of the middle- to lower-continental crust offer a unique opportunity to study the thermal, chemical, and mechanical processes deep within orogenic systems. Classically held models of orogeny involve a single cycle of crustal thickening followed by exhumation that reproduces simple pressure-temperature-time paths observed in several exhumed metamorphic terranes (e.g., England and Thompson, 1984). Many exhumed orogens, however, record multiple episodes of thickening, exhumation, magmatism, and orogen-parallel translation that produce more complicated metamorphic histories than predicted by a single orogenic event (e.g. McLelland et al., 1988; Sylvester, 1988; Brown and Walker, 1993; Paterson et al., 1994; Mulcahy et al., 2014; Sauer et al., 2017b)). Therefore, testing these models requires detailed metamorphic, structural, and geochronological studies to reconstruct their pressure, temperature, and time histories.

Western North America preserves a complex series of orogenic belts that record >300 million years of accretion-related deformation, metamorphism, and associated igneous activity. The Coast Plutonic Complex (CPC), which extends nearly 2000 km from northern Washington state to southern Alaska (Figure 1), exposes the igneous and metamorphic roots of an ancient arc that preserves >100 million years of deformation, magmatism, and metamorphism from mid-Jurassic to Middle-Eocene time (e.g., Umhoefer and Miller, 1996). The southern extent of this magmatic arc in northern Washington state, the Cascades Crystalline Core (Figure 1, 2), preserves high temperature (≤750 °C) (e.g. Whitney, 1992) middle to lower crustal rocks (~10-30 kilometer deep igneous, metasedimentary, and metaplutonic rocks) (Valley et al., 2003; Miller et al., 2009) allowing a world class opportunity to study the inner workings of an ancient arc (Evans and Berti, 1986; McGroder, 1991; Whitney, 1992; Brown and Walker, 1993; Evans and Davidson, 1999; Miller and Paterson, 2001; Stowell and Tinkham, 2003; Brown and Gehrels, 2007; Stowell et al., 2011; Wintzer, 2012; Miller et al., 2016; Sauer et al., 2017a, 2017b, 2019).

In the region surrounding the Mount Stuart Batholith in the southern Cascades Crystalline Core, researchers (e.g. Evans and Berti, 1986; Brown and Walker, 1993; Paterson et al., 1994; Evans and Davidson, 1999) have recognized three distinct metamorphic events (M1, M2, and M3) (Figure 3). These events have been defined as low-pressure regional M1 with the presence of garnet - biotite ± cordierite ± amphibole assemblages, low-pressure contact metamorphism M2 with the presence of andalusite-sillimanite assemblages related to the intrusion of the Mount Stuart Batholith and satellite plutons, and high-pressure metamorphism M3 with kyanite-staurolite after andalusite assemblages produced by increases in pressure and temperature related to burial.

A vast majority of the ages of the rocks in the Cascades Crystalline Core are either igneous/detrital U-Pb zircon ages or K-Ar/Ar-Ar cooling ages of igneous/metamorphic amphibole and mica. Many researchers (Tabor et al., 1989; Magloughlin, 1993; Chace et al., 1998; Evans and Davidson, 1999; Stowell and Tinkham, 2003; Stowell et al., 2011; Holler, 2013) have attempted to date the metamorphic host rocks using ever evolving techniques, however, few dated the earliest M1 event.

Two competing tectonic models for mechanisms behind the M3 evolution of the Cascades Crystalline Core have been proposed to explain ~90 Ma crustal thickening event. Some authors hypothesize that crustal thickening recorded across the Cascades Crystalline Core resulted from region-wide multi-kilometer-thick thrust sheets (e.g.

Whitney and McGroder, 1989; McGroder, 1991; Whitney, 1992). In contrast, Brown and Walker (1993) propose that this burial resulted from the emplacement of large shallow plutons such as the Mount Stuart batholith (Figure 2, 3). Regardless of the mechanisms behind the burial, both models agree that the crust was substantially thickened to >55 or more km (Miller and Paterson, 2001; Paterson, 2017, *personal communication*) by 90 Ma.

Previous workers (e.g., Stowell and Tinkham (2003) and Stowell et al. (2011)) have dated rocks affected by the M3 event however they were not able to determine if the two end member models (or some combination) caused the rapid crustal thickening. High-temperature and high-precision ages combined precise pressure and temperature determinations may be able to shed some light on the underlying cause of the M3 event.

I combined petrological observations, thermodynamic modeling, pressure and temperature calculations, detailed analysis of garnet major and trace elemental zoning, garnet Lu-Hf and Sm-Nd geochronology, and a comprehensive analysis of all existing Wenatchee block geochronology to constrain the metamorphic history of the southern Wenatchee block of the Cascades Crystalline Core to answer three broadly unanswered questions; (1) What is the age of each metamorphic event in the Wenatchee block (M1, M2, and M3) and how do they compare to established pluton ages?, (2) Was metamorphism continuous or episodic with respect to garnet growth? (are different generations of garnet preserved), and (3) are the Tonga Formation and Chiwaukum Schist metamorphically related beyond sharing a common Rb-Sr protolith signature

GEOLOGIC BACKGROUD

The Cascades Crystalline Core is the southernmost exposure of the Jurassic to Paleogene Coast Plutonic Complex, which extends nearly 2000 kilometers from southern

Alaska to north-central Washington state (Figure 1). This complex is primarily composed of medium to high grade pelitic schists and gneisses and intermediate composition arc-type volcanic/plutonic rocks. Described in detail here, the Cascades Crystalline Core is the fault bounded southern extension of this ancient arc chain. The dextral Straight Creek-Fraser River fault system (SCFR) offsets the western edge of the Cascades Crystalline Core from the southeastern edge of the Coast Plutonic Complex. Presently, the SCFR separates the Cascades Crystalline Core to the west from the predominantly Paleozoic–Early Cretaceous ocean floor, ophiolite, island arc, and trench deposits of the Northwest Cascades Thrust System (NWCS) and the western mélange belt (e.g. Brown and Gehrels (2007). To the northeast the Ross Lake fault zone separates the Cascades Crystalline Core from the Methow terrane (a Jurassic–Cretaceous fore-arc sequence) (e.g. Whitney and McGroder, 1989; McGroder, 1991; Whitney, 1992).

The Cascades Crystalline Core is subdivided into two distinct blocks by the Eocene northwest-southeast trending high-angle dextral Entiat fault system, with the Wenatchee block to the southwest and Chelan block to the northeast. The two blocks preserve different metamorphic and plutonic histories. The Chelan block, comprised predominantly of the Skagit gneiss and Swakane gneiss, records episodic magmatism from ca. 96 Ma to ca. 45 Ma with associated igneous and metamorphic Ar-Ar and K-Ar amphibole and mica cooling ages (Tabor et al., 1989; Matzel et al., 2006; Gordon et al., 2010; Sauer et al., 2017a, 2017a). The Wenatchee block (Figure 2) is composed of the Nason terrane, which contains the Nason Ridge Migmatitic Gneiss to the north, the centrally located predominantly calc-alkaline Mount Stuart batholith, the dominantly pelitic Chiwaukum Schist to the south, and Tonga Formation (a lower metamorphic grade pelitic schist) to the west. South of the Chiwaukum Schist, the Windy Pass thrust of Miller (1985) juxtaposes the middle Jurassic Ingalls ophiolite of the Northwest Cascades Thrust System onto the middle Cretaceous Chiwaukum Schist. The thrust contact is partially intruded by the 96–92 Ma Mount Stuart Batholith (Tabor et al., 1989; Matzel et al., 2006; Miller et al., 2009).

The Wenatchee Block

Chiwaukum Schist

The Chiwaukum Schist (Figure 2 and Figure 4) contains metapelite, scattered lenses of marble, amphibolite, and ultramafic rock that was intruded by a series of mid-Cretaceous calc-alkaline plutons, largely the Mount Stuart batholith (Yeats et al., 1977; Plummer, 1980; Evans and Berti, 1986; Tabor et al., 1989; Walker and Brown, 1991; Brown and Walker, 1993). The Chiwaukum Schist records at least three metamorphic events (Figure 3 and Figure 4) (Plummer, 1980; Evans and Berti, 1986; Evans and Davidson, 1999). Within the Chiwaukum Schist, M1 is recognized predominantly in the area around Icicle Canyon (Figure 4) by the presence of deformed garnet - chlorite - biotite ± cordierite ± amphibole assemblages with metamorphic pressures of 3.0-4.0 kilobar. The timing of M1 post-dates the detrital zircon maximum depositional age range of the Chiwaukum Schist of ~120 Ma, (Paterson, 2014; Paterson, 2020, *personal communication*), and predates the intrusion of the Mount Stuart Batholith (Figure 3). The second metamorphic event, M2, is recognized as contact metamorphism related to the intrusion of the Mount Stuart batholith by the presence of chlorite - andalusite - biotite ± garnet ± sillimanite assemblages near the intrusion (Figure 3). The final metamorphic event, M3, is recognized by higher metamorphic pressures, up to 10 kilobar, and the presence of garnet – staurolite – kyanite – biotite ± sillimanite assemblages (Figure 3).

Mount Stuart batholith

The Mount Stuart batholith is the largest exposed intrusive body in the Cascades Crystalline Core (Figure 2, 3). Composition ranges from an early two-pyroxene gabbro to a main phase of tonalite-diorite-granodiorite (Erikson, 1977; Evans and Berti, 1986). The Mount Stuart batholith intruded the Ingalls ophiolite to the south ca. 93 Ma at a depth of ~4.5 km and the Chiwaukum Schist and the southern Nason Ridge Migmatitic gneiss to the north ca. 96 Ma at a depth of ~9 km (Ague and Brandon, 1996). Paleomagnetic studies, in conjunction with published Ar-Ar and K-Ar data, suggest that the southern Mount Stuart batholith had cooled below the magnetite closure temperature of ~580°C by 91 Ma while the northern portion cooled through the magnetite closure temperature by 86 and the pyrrhotite closure temperature of ~320 by 83 Ma (Housen et al. (2003)). The rapid ~170°C cooling in the southern Mount Stuart batholith in roughly two million years allowed Housen et al. (2003) to determine that by 91 Ma the southern portion of the batholith was at a latitude of 31.3 +3.8°/-3.4°N, ~2000 km south of its current location, similar to the results of Beck and Noson (1972) and Beck et al. (1981).

The intrusion caused the development of a kilometer-wide contact aureole identified by the presence of metamorphic andalusite/sillimanite and a change in metamorphic foliation from low-angle to high-angle due to downward transfer of pluton adjacent material, chiefly the Chiwaukum Schist, along the margin of the batholith (Paterson and Miller, 1998). Along the margins of the Mount Stuart batholith, the contacts are generally steep in the southeast and dip moderately to steeply in the central and northwest regions (Paterson and Miller, 1998).

The Tonga Formation

The Tonga Formation (Figure 2 and Figure 4) is a deformed, heterogeneous assemblage of graphitic sub-chlorite to staurolite-grade phyllite, schist, and metabasite intruded by the Beckler Peak pluton and Excelsior Mountain orthogneiss, both interpreted as satellites of the Mount Stuart Batholith (Yeats and Engels, 1971; Yeats et al., 1977; Duggan and Brown, 1994; Jensen et al., 2009). The Tonga Formation is separated from the Chiwaukum Schist to the east by the Evergreen fault, to the west from the Darrington phyllite and Shuksan greenschist by the Straight Creek-Fraser River Fault system, and terminates to the north at the southern margin of the 96 Ma Excelsior Mountain orthogneiss, which is interpreted to intrude the contact between the Tonga Formation and Chiwaukum Schist (Brown and Gehrels, 2007) (Figure 4). Monger (1991) postulated that the Tonga Formation and the Shuksan green/blueschist shared a similar protolith, however, Duggan (1992) and Duggan and Brown (1994) suggested, on the basis of Rb-Sr isotopes, that the Tonga Formation sediments are more similar to the Chiwaukum Schist and postulated the rocks as a structurally higher portion of the Chiwaukum Schist. Analysis of detrital zircons published by Brown and Gehrels (2007), Paterson (2014), and Paterson (2020 *personal communication*) and Rb-Sr and Sm-Nd isotopes by Magloughlin (1993) confirm a similar protolith and similar maximum depositional age of ~120 for both the Chiwaukum Schist and Tonga Formation.

Wenatchee Block Fabrics

Evidence for multiple episodes of deformation were recognized across the Cascades Crystalline Core as early as the mid 1960's (e.g. Yeats, 1958 and Misch, 1967) (Figure . By the early 1990's enough data had been collected in the Wenatchee block for (Paterson et al., 1994) to recognize five and one half (T1-5) unique "transposition cycles" defined by Tobisch and Paterson (1988) and clarified by Paterson et al. (1994) as "episodes of ductile deformation...during which old structures were transposed parallel to new structures or new orientations while being overprinted by younger structures." These transposition cycles can be thought of as unique fabric forming events with whole events (1,2,3, etc.) resulting in the formation of a fabric and half events (etc. 2.5, 5.5) reorienting previous events (i.e. folding) but not forming a new fabric. These half events are generally observed in outcrop scale and can be easily missed in thin section. Distinct fabrics formed through a transposition cycle are transcribed from T1, T2, T3, T4, T5 and used later as S1, S2 S3, S4, S5 with T1=S1 etc. Paterson et al. (1994) defines transposition 1-2.5 (M1 and fabrics S1-S2) to reflect regional progressive deformation during NE-SW contraction with simultaneous perpendicular NW-SE extension related to M1 metamorphism; transposition cycle 3 (M1-M2 and fabric S3) is defined as transposition of 1-2.5 structures by the Windy Pass Thrust; transposition cycle 4 (M2 and fabric S4) reflects emplacement of the Mount Stuart Batholith reorienting near-batholith structures parallel to the batholith margin; and transposition cycle 5-5.5 (M3 and fabric S5) formed syn to post batholith emplacement related to regional NE-SW contraction (Figure 3 and 4).

Existing Geochronology

Little direct high temperature (≥600°C) metamorphic geochronologic evidence exists in the southern Cascades Crystalline Core (Figure 5). Many existing metamorphic ages are based on the ages of pre-, syn-, and post-deformation plutons, dikes, and sills and their relationship to the surrounding rocks. Early researchers including Plummer (1980) and Evans and Berti (1986) concluded that three metamorphic events may be preserved within the southern Wenatchee block. The earliest metamorphic event, M1 or T1-T2+ of Paterson et al. (1994), is constrained by a series of Sm-Nd garnet ages from the Chiwaukum Schist within Icicle canyon (Figure 4 and Figure 5) that range from 125-103 Ma (Magloughlin, 1993; Chace et al., 1998),. Similarly old ages between 133-104 Ma occur in the Nason Ridge Migmatitic Gneiss (Holler, 2013) but are discounted by the author due to low isotopic separation between garnet and whole rock fractions (low $^{147}Sm/^{144}Nd$ ratios) interpreted as a result of lattice diffusion during metamorphism, errors during analysis, disequilibrium between REE-inclusions and garnet, or REE separation and purification errors.

The second metamorphic event, M2 or T4 of Paterson et al. (1994), was low-pressure contact metamorphism associated with the intrusion of Mount Stuart batholith and led to the growth of andalusite, cordierite, and locally sillimanite (e.g. Evans and Davidson, 1999). The ages of these syn emplacement fabrics come from igneous zircons derived from the Mount Stuart batholith that range from 96 to 92 Ma.

The youngest metamorphic event, M3 or T5 of Paterson et al. (1994), followed closely after emplacement of Mount Stuart batholith between 91 and 86 Ma (Stowell et al., 2011). This event is distinguished from M1 and M2 by the presence of kyanite-staurolite and sillimanite-staurolite assemblages after andalusite indicating increases in pressure and temperature. Two alternative models have been proposed to explain the M3 metamorphic fabrics observed in the southern Wenatchee block: magma loading

(Brown and Walker, 1993) and thrust loading (Whitney and McGroder, 1989; McGroder, 1991). The magma loading model suggests that large, young (<92 Ma) plutons were emplaced shallow in the crust causing burial of smaller/older plutons to depth, similar to what is described by Brown and Walker (1993) in the Settler schist to the north. The thrust loading model also suggests burial, but by regional scale thrust sheets during NE-SW shortening. The timing of this M3 event is constrained by limited U-Pb monazite ages that date peak metamorphism around 90 Ma (Brown and Walker, 1993), 92-86 Ma Sm-Nd garnet ages by Magloughlin (1993), Stowell and Tinkham (2003), and Stowell et al. (2011), and subsequent cooling through the Ar/Ar and K-Ar closure temperatures of hornblende, muscovite, and biotite beginning at 91 Ma in the south and 86 Ma in the north (Figure 5) (e.g. Evans and Davidson, 1999; and references within Housen et al., 2003). The M3 garnet ages in the Chiwaukum Schist can be explained by either garnet growth syn- to post-pluton emplacement or by partial to full re-equilibration of isotopic systems within older grains possibly by thermal relaxation post-pluton emplacement. If new and existing garnet ages from regions mapped as M3 are syn to post M2 pluton emplacement, then magma loading may be favored because the igneous temperatures associated with intrusive bodies would heat the surrounding rocks at a more rapid rate than if a warm (yet cooler than a magma chamber) thrust sheet from deeper in the crust slowly buried the region. If garnet ages are conclusively post M2 pluton emplacement and fall between igneous zircon and metamorphic Ar/Ar cooling ages in regions mapped as M3 then the garnet Lu-Hf and Sm-Nd ages may date thermal re-equilibration/cooling post loading favoring thrust loading over magma loading.

METHODS

Mineral Major and Trace Element Chemistry

Seven pelitic samples were selected for chemical analysis from samples collected during the summer 2018 field season from across the Chiwaukum Schist and Tonga Formation so that pressure and temperature calculations could be completed (sample locations and mineralogies are summarized in Figure 2, Table 1 and Table 2. These samples were selected based on their location near previously identified metamorphic fabrics of (Paterson et al., 1994) and mineral relationships to these fabrics.

Before chemical analysis, sample thin sections were analyzed using a Leica polarized stereoscope model DM 2700P for mineral identification and determination of textural relationships. Major element weight percent oxide chemistry of garnet, biotite, muscovite, amphibole, cordierite and staurolite were then collected using a JEOL JSM-7200F Schottky Field Emission Scanning electron microscope (FE-SEM) equipped with a 150 mm^2 Oxford X-Max energy dispersive X-ray spectroscopy (EDS) detector, and a retractable backscatter detector. Typical SEM operating conditions consisted of an accelerating voltage of 20 Kev, a probe current between seven and eight, a column aperture diameter of 50 micrometers, an EDS deadtime of 15 to 20 percent, and an EDS processing time of 5. All samples were carbon coated (density of 2.00 g/cm^3) to a known thickness, usually 20-25 nanometers, using a Cressington 108C rotary Carbon Evaporating Unit with an accompanying thickness monitor. All analyses were optimized to copper tape and standardized with an extended internal standard data set provided in the Oxford instruments Aztec software. Garnet profiles were measured on transects from the core to the rim (Table 3). Data quality of individual mineral analyses were assessed using the descriptions in Kohn (2014).

To analyze the trace elemental zoning characteristics of the garnets from the seven samples, rim to rim trace element concentrations (Table 4) were determined for garnet grain mounts from each sample by LA-ICPMS in the Advanced Material Science and Engineering Center (AMSEC) at Western Washington University using an Agilent 7500ce Inductively Coupled Plasma Mass Spectrometer (ICPMS) with a New Wave UP-213AS laser ablation(LA) accessory utilizing a 213nm UV Nd:YAG class IV laser. Grain mounts were used instead of thin sections to ensure proper exposure of the core and rim of each grain and to eliminate any issues associated with tunneling through the garnet into the epoxy and glass slide with the laser. Time resolved data with a 1 millisecond integration time were collected using a 55-micrometer spot size and an acquisition time of 120 seconds comprised of a 30 second background and 90 second ablation time. All analyses used a 1500 W forward power, a 10 Hz repetition rate, a 13.7 J/cm2 fluence, and a carrier gas flow rate of 400 mL/min. Each analysis was calibrated to NIST 610 and 612 glasses using values determined by using an internal standard of aluminum determined by SEM analysis. Elements analyzed include Na, Mg, Al, Si, P, Ca, Sc, Ti, Mn, Fe, Y, Zr, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, and Hf. GLITTER data reduction software with signal selection was used to avoid any inconsistency within garnet analyses (cracks, inclusions, etc.) (van Achterbergh et al., 1999). Ablation pit separation was measured using the measurement function in the Olympus SZX16 Research Stereomicroscope Optical Microscope computer software also housed in the AMSEC facility.

Bulk Rock Major and Trace Element Analysis

To model sample equilibrium assemblage diagrams, also known as pseudosections, bulk rock major element concentrations from each sample of interest was needed. Samples for bulk rock major and minor element analysis were selected from collected samples based on three parameters: mineralogy suitable for thermobarometry and thermodynamic modeling, free of obvious alteration and weathering rinds to ensure that the bulk composition was not altered, and the presence of abundant inclusion free garnet with a clear relationship to the fabric so that garnet was a good candidate for geochronology. Seventeen samples that met the above criteria were taken to the Peter Hooper GeoAnalytical Lab in the School of the Environment at Washington State University (WSU) for bulk rock major, minor, and trace elemental analysis via X-ray fluorescence (Table 5). Representative 250-300 gram hand samples of each sample were crushed, mechanically split into a 15 gram aliquot to avoid unnecessary human introduced fractionation, powdered in a tungsten carbide grinding bowl, fused using pure di-lithium tetraborate powder, to lower the melting point, at 1000°C for ~30 min in pure carbon crucibles, re-powdered in a tungsten carbide grinding bowl, fused again at 1000°C, and polished to a uniform surface roughness prior to analysis to ensure uniform X-ray reflectance. The elements Si, Al, Ti, Fe, Mn, Ca, Mg, K, Na, P, Sc, V, Ni, Cr, Ba, Sr, Zr, Y, Rb, Nb, Ga, Cu, Zn, Pb, La, Ce, Th, Nd, and U were analyzed using a ThermoARL Advant'XP+ sequential X-ray fluorescence spectrometer with an average analysis time of 65 minutes.

Thermobarometry and Thermodynamic Modeling

Quantitative weight percent oxide mineral chemistry was determined from each sample using SEM-EDS and was used to calculate the average metamorphic pressure and temperature conditions of each sample (Table 3). To approximate peak metamorphic conditions for each sample, the highest garnet magnesium number (Mg / (Mg + Fe)) was paired with matrix mineral compositions (i.e. feldspar, biotite, muscovite, staurolite) directly adjacent to the rim of the analyzed garnet. The weight percent oxide mineral composition data was first processed through AX (Powell and Holland, 1994) to calculate the activities of the end-members using published activity models at a pressure and temperature of 6 kilobar and 600°C. The cation activities are then input into the Average PT method in the program THERMOCALC (Powell and Holland, 1994), using the dataset of Holland and Powell (2003) to calculate the metamorphic pressure and temperature conditions of the equilibrium metamorphic assemblage. This software package calculates a set of independent reactions based on the input mineral activities to calculate an equilibrium pressure and temperature condition of the assemblage. The goodness of fit for the equilibrium pressure and temperature condition was assessed using the sigma fit of the determination (equivalent to the MSWD) and the expected value of sigma fit (fit) that is a function of the number of independent reactions used in the calculation. The pressure and temperature conditions can then be plotted in P-T space using P-T data as central location with error and the correlation coefficient of the uncertainties (corr) to determine the shape and orientation of the uncertainty ellipse.

Isochemical pressure-temperature phase diagrams (pseudosections) were modeled using the bulk rock major element compositions (Table 5) and the MS-DOS based program Theriak-Domino (version 04/02/2017) updated from de Capitani and Petrakakis (2010). Theriak uses linear programming combined with minimization of single thermodynamic solution functions to produce the correct mineral assemblage even for extremely complex systems. However, Domino, used exclusively here, computes equilibrium assemblage diagrams, referenced here as pseudosections, based on specific bulk compositions and minimization calculations of Gibbs free energy. The pseudosection diagrams were constructed over 400-700°C and 1-10 kilobar using the internally consistent data set of de Capitani and Petrakakis (2010). The following solution models were used: chlorite model, cordierite, staurolite, and chloritoid models of Holland and Powell (1998), white mica model of Coggon and Holland (2002), the spinel and orthopyroxene models of White et al.(2002), plagioclase model of Holland and Powell (2003), Mn-garnet, biotite, and ilmenite models of White et al. (2005), and liquid (melt) model of White et al. (2007). The peak mineral assemblage interpreted from each sample was compared to the stability fields predicted by the pseudosections to estimate peak pressure and temperature conditions of the observed mineral assemblage in each sample. This estimate was compared with the average pressure and temperature calculations (Table 6) to ensure accuracy of both methods.

In order to understand the initial metamorphic conditions and prograde metamorphic path, garnet end-member isopleths for garnet core compositions measured from each sample (Mg, Mn, Fe, and Ca) were modeled over the same pressure and temperature range. The intersection of isopleths constrain the pressure and temperature conditions at which the garnet growth initiated.

Garnet Geochronology

Garnet is a powerful geochronometer because it can be used to date high-temperature metamorphism in rocks that have experienced single and multi-phase garnet growth. Unlike most mineral systems (i.e. U-Pb in zircon and monazite or Ar-Ar in hornblende, biotite, and muscovite), garnet is unique in that it contains two isotopically distinct datable systems; Lu-Hf and Sm-Nd. Garnet is datable because of high Sm/Nd and Lu/Hf ratios and that pure garnet readily incorporates heavier rare earth elements like Sm^{+3} and Lu^{+3} while preferentially excluding Nd^{+3} and Hf^{+4} based on ionic size (Nd^{+3} has a larger ionic radius than Sm^{+3}) and because of charge differences (non REE Group 4 (IVb) metal +4 Hf versus HREE +3 Lu). Over the last 20 years researchers have used both systems together and separately to date metamorphism in a range of tectonic environments (see references in Baxter et al., 2017).

The ability to obtain two isotopically dissimilar ages from one garnet presents challenges and opportunities. Dating both systems can yield two different ages such as the systematic 60 Ma separation between both systems described in Johnson et al. (2018). The alternative ages present the challenge of interpreting both ages in a geological context. The age differences result from, but are not limited to, differences in closure temperature between the two systems and isotopic disequilibrium between garnet and any micro-inclusion contained within the garnet (shown to only affect the Sm-Nd system by Scherer et al. (2000) and Johnson et al. (2018). The closure temperatures for Sm-Nd and Lu-Hf in garnet are not well constrained but are estimated to be ≥640 ˚C for the Sm-Nd system and ≥750 ˚C for the Lu-Hf system (Mezger et al., 1992; Scherer et al., 2000; Smit et al., 2013). Ideally, dating using both systems together would be reserved for high temperature geologic settings (≥700°C) between the different closure temperatures of the two systems such that different in ages result. When dated together, this difference in closure temperature can allow estimation of metamorphic duration (Lapen et al., 2003).

Garnet-garnet free whole rock Lu-Hf and Sm-Nd ages for all samples were determined at Washington State University following the procedure outlined by Johnson et al. (2018) and summarized in appendix A. Garnet porphyroblasts were separated by hand crushing, magnetic separation, and handpicking of individual grains. Ages were calculated with the ^{176}Lu decay constant values of Söderlund et al. (2004) and ^{147}Sm decay constant values of Lugmair and Marti (1978). Isotopic data are reported with the associated 95% confidence interval.

RESULTS

Petrology and Thermobarometry

Several distinctions are used to compare and characterize samples in the following section. For the Chiwaukum Schist these are chiefly related to the relationship of sample specific fabrics to regional distinctions made by Paterson et al. (1994). Individual sample fabrics are related to specific regionally recognized events (i.e. the windy pass thrust signified as S3) based on how they were mapped by Paterson et al. (1994) and the number of fabrics present in a certain sample (i.e. some samples may only preserve S1,S2 and S3 fabrics and others may only preserve S4 and S5 fabrics). Some sample locations were previously mapped by Paterson et al. (1994) as containing up to three fabrics however only one or two distinct fabrics may be present within a sample. These present fabrics are linked with a fabric using mineral relationships to the fabrics. The fabrics within Tonga Formation samples are related to a metamorphic event (M1-3) and labeled as S1, S2, S3 etc. for each sample as the regional sample to sample deformational relationship has not been identified.

Chiwaukum Schist

Sample 191-03a is an And-Chl-Grt-Crd-Bt schist (abbreviations after (Whitney and Evans, 2010)) from the Mount Stuart trailhead in Icicle Canyon (Table 1) and was previously mapped as M1-M2 (S1-S3) by Paterson et al. (1994). The sample has a dominant foliation inferred to represent S3 is defined by aligned biotite, plagioclase feldspar, and quartz bands that may be related to S3 reorientation (Figure 6A and 7A). Biotite is generally aligned with the foliation; however, in rare cases the observed cleavage plane is at high angle to the foliation. Relict andalusite is wrapped by the foliation and partially replaced by quartz, biotite, garnet, and spinel (Figure 7A). Cordierite occurs as large mats across the sample with inclusions of biotite and plagioclase feldspar. A single population of garnet is preserved as euhedral grains that are wrapped by the foliation (Figure 7A). Quartz, biotite, plagioclase feldspar, muscovite, and ilmenite occur as inclusions within both garnet populations. Internally, garnet preserves multiple inclusions of biotite as a growth ring within each grain that may be related to an earlier fabric(S1-S2).

Sample 191-04a is a Chl-Grt-Bt schist with accessory tourmaline from near the Chatter Creek ranger station in Icicle Canyon (Figure 2, Figure 6B) previously mapped as S1-S2 and M1 by Paterson et al. (1994). The sample has a single foliation inferred to represent S2 is defined by alignment of biotite, plagioclase feldspar, and quartz bands (Figure 7B). Biotite is generally aligned with the foliation; however, in rare cases the observed cleavage plane is at high angle to the foliation. Tourmaline occurs adjacent to biotite and garnet and overgrows the foliation (Figure 7B). A single generation of garnet porphyroblasts overgrow and locally are wrapped by the main foliation (Figure 7B). Internally, garnet preserves multiple inclusions of biotite as a growth ring within each grain that may be related to an earlier fabric(S1-S2) (Figure 7B).

Sample 191-05a is a Grt-Amp-Bt schist from near the Rock Island campground in Icicle Canyon (Figure 2, Figure 6C) previously mapped as S1-S2 and M1 by Paterson et al. (1994) however only a single foliation is observed within the sample. The sample has a single foliation inferred to represent S2 is defined by alignment of biotite, plagioclase feldspar, and quartz bands (Figure 7C, D). In many locations in the outcrop this foliation is folded by F3 folds (Figure 6C) however this sample remained unfolded. Biotite is generally aligned with the foliation; however, in rare cases the observed cleavage plane is at high angle to the foliation. A single generation of garnet porphyroblasts is wrapped by and locally overgrows the main foliation (Figure 7D). Garnets are usually inclusion free; however, quartz is sometimes present and defines an internal foliation subparallel to that of the external foliation. A single generation of amphibole (cummingtonite-grunerite solid solution series) porphyroblasts overgrow the foliation and have quartz and local biotite as inclusions (Figure 7C). Garnet zoning profiles display typical growth zoning with X_{Sps} decreasing from core to rim, X_{Pyr} and X_{Alm} increasing from core to rim, and relatively constant X_{Grs} concentrations (Table 3 and Figure 8A, B). Adjacent to the garnet rim X_{Sps}, X_{Grs}, and X_{Alm} increase and X_{Pyr} concentrations decrease suggesting major element re-equilibration during retrograde metamorphism (Table 3 and Figure 8A, B). Garnet with the highest X_{Mg} concentrations were paired with matrix Bt, Pl, and Amp.

Calculated metamorphic conditions for M1 in this sample are 2.9 ± 1.2 kilobar and 650±25 C (Table 6).

Sample 191-46c is a Grt-Crd-Bt schist with accessory ilmenite and chlorite and collected near Lake Caroline in the footwall of the Windy Pass thrust (Figure 2, Figure 6D, E) previously mapped as S1-S3 and M1 by Paterson et al. (1994). The sample contains two foliations. The oldest foliation inferred to represent S1-S2 is defined by biotite, plagioclase feldspar, and quartz as inclusions within cordierite at high angle to the main dominant foliation (Figure 7E). The dominant foliation inferred to represent S3 is defined by biotite, plagioclase feldspar, and quartz (Figure 7E, F). Cordierite occurs as porphyroblasts wrapped by the foliation (Figure 7E) and as small inclusions in biotite. Larger cordierite grains contain inclusions of aligned biotite and quartz at high angle to the dominant foliation (Figure 7E). Garnet porphyroblasts are wrapped by the foliation and contain inclusions of quartz and occasionally plagioclase that define an internal foliation at high angle to the present foliation (Figure 7F). Garnet is typically mantled by quartz and plagioclase with rare occurrences of biotite in direct contact with the garnet rim (Figure 6F). Garnet zoning profiles display typical growth zoning with X_{Sps} decreasing from core to rim, X_{Pyr} and X_{Alm} increasing from core to rim, and X_{Grs} concentrations are relatively constant across the grain (Table 3 and Figure 8 C, D). Adjacent to the garnet rim X_{Sps} and X_{Alm} concentrations increase, X_{Pyr} concentrations decrease, and X_{Grs} concentrations remain constant suggesting major element re-equilibration during retrograde metamorphism (Table 3 and Figure 8 C, D). Garnet compositions with the highest X_{Mg} were paired with matrix cordierite, biotite, and plagioclase. Calculated metamorphic conditions for M1 in this sample are 4.5±1.1 kilobar and 613±73°C (Table 6).

Samples 191-10a and 191-10b are graphitic Chl-And-Grt-Bt schist with accessory muscovite and pyrite previously mapped as S4 and M2 by Paterson et al. (1994) and Evans and Berti (1986). The samples were collected near Tunnel Creek on US Highway 2 between the western and eastern lobes of the Mount Stuart Batholith (Figure 2, Figure 6F and G). The sample has a single foliation inferred to represent S4 is defined by graphite, biotite, quartz, and plagioclase feldspar. Chlorite replaces biotite and preserves inclusions of the foliation, chiefly graphite. Relict andalusite is wrapped by the foliation and partially replaced by chlorite, quartz, biotite and muscovite (Figure 7H). A single population of garnet is present that is generally wrapped by the foliation and in places cuts the foliation. Garnet generally lacks inclusions, but locally contains inclusions of quartz (Figure 7G). Garnet zoning profiles display typical growth zoning with X_{Sps} decreasing from core to rim, X_{Pyr} and X_{Alm} increasing from core to rim, and X_{Grs} concentrations are relatively constant across the grain (Table 3 and Figure 8E, F). Adjacent to the garnet rim X_{Grs} concentrations increase, X_{Sps} concentrations level off, and X_{Pyr} concentrations decrease suggesting major element re-equilibration during retrograde metamorphism (Table 3 and Figure 8E, F). Garnet with the highest X_{Mg} concentrations were paired with matrix biotite, plagioclase, and endmember andalusite. Calculated metamorphic conditions for M2 in this sample are 4.2±1.7 kilobar and 556±103°C (Table 6).

Sample 191-41 is a Grt-And-Bt schist with accessory tourmaline and chlorite. The sample was collected from the northern margin of the western lobe of the Mount Stuart batholith (Figure 2) previously mapped as S4 and M2 by Paterson et al. (1994), Evans and Berti (1986) and others. Two foliations are present within the sample. The dominant foliation inferred to represent S4-S5 is defined by biotite, quartz, and plagioclase feldspar (Figure 7I and J). The second foliation inferred to represent S1-S2 or S4 is preserved as quartz, plagioclase feldspar, and biotite inclusions within andalusite (T1-T4) (Figure 7I). Relict andalusite is wrapped by the second foliation and is partially replaced by quartz, and plagioclase feldspar and garnet (Figure 7I). In this sample, garnet growth is associated with the breakdown of andalusite and is present as a direct replacement. Inclusions within garnet include biotite, quartz, tourmaline, and andalusite.

Sample 191-22a is a St-Grt-Sil-Bt schist with accessory muscovite and was collected from near Heather Lake, North of Mount Stuart Batholith (Figure 2, Figure 6H and I) mapped as S5 by Paterson et al. (1994) and Stowell and Tinkham (2003) . The sample contains two foliations. The dominant foliation inferred to represent S5 is defined by biotite, quartz, plagioclase feldspar, and the fibrolite form of sillimanite (Figure 7K and L). Staurolite occurs within the foliation as small blocky grains clustered together, associated with biotite, sillimanite, and quartz (Figure 7L). Two populations of biotite are present in the sample (Figure 7K and L). One population is aligned with the foliation and the other population is preserved in pressure shadows adjacent to garnet at high angle to the dominant foliation and is inferred to represent an older foliation related to S1-S2 or S4. A single generation of garnet is present with rare inclusions of quartz and garnet grains are wrapped by the foliation. Garnet zoning profiles display typical growth zoning with X_{Sps} decreasing from core to rim, X_{Pyr} and X_{Alm} increasing from core to rim, and X_{Grs} concentrations are relatively constant across the grain (Table 3 and Figure 8G, H).

Garnet with the highest XMg concentrations were paired with biotite, plagioclase, muscovite, staurolite, and endmember sillimanite. Calculated M3 metamorphic conditions for this sample are 6.3±1.5 kilobar and 646±33°C (Table 6), similar to those reported by Stowell and Tinkham (2003) for similar rocks in the area.

Sample 191-08a is a Ms-St-Ky-Grt-Bt schist with accessory rutile, ilmenite and minor retrograde chlorite that was previously mapped as S5 and M3 by Paterson et al. (1994) and Brown and Walker (1993). The sample was collected along US Highway 2 on the NE side of the Mount Stuart batholith (Figure 2, Figure 6J). The sample contains two foliations. An early foliation inferred to represent S1-S2 or S4 is defined by aligned quartz, plagioclase feldspar, and muscovite as inclusions within staurolite (Figure 7N). The dominant foliation inferred to represent S5 is defined by biotite, quartz and plagioclase feldspar in the matrix (S5) (Figure 7M and N). Muscovite overgrows the S5 foliation and replaces staurolite, kyanite, and garnet. Pre-kinematic staurolite, with respect to the S5 foliation, preserves an internal foliation (S1, S2, or S4) defined by quartz and a fine black mineral and occurs at an oblique angle to the T5 foliation (Figure 7N). Staurolite is partially replaced by biotite, quartz, chlorite, and kyanite (Figure 7M). Kyanite occurs in direct contact with irregular grain boundaries of garnet and staurolite as reaction rims with biotite, muscovite, and quartz (Figure 7M and N). Inclusions of quartz, rutile, ilmenite, and plagioclase feldspar in kyanite are common. Biotite occurs as aligned grains within the matrix (Figure 7M and N). Rutile is present as inclusions within ilmenite and as rare inclusions in staurolite (Figure 7N). Garnet porphyroblasts are wrapped by the foliation and are partially replaced by quartz, muscovite, and biotite with large inclusions of quartz, muscovite, and biotite common (Figure 7M). Garnet zoning profiles display typical growth zoning with X_{Sps} and X_{Grs} compositions decrease from core toward the rim while X_{Pyr} and X_{Alm} concentrations increase from core toward the rim (Table 3 and Figure 8I, J). Within 300 μm of the garnet rim, X_{Sps} and X_{Grs} concentrations increase while X_{Alm} and X_{Pyr} concentrations decrease suggesting major element re-equilibration during retrograde metamorphism (Table 3 and Figure 8I, J). Garnet with the highest X_{Mg} concentrations were paired with matrix biotite, plagioclase, staurolite, and endmember kyanite. Calculated M3 metamorphic conditions for this sample are 7.1±0.8 kilobar and 639±23°C (Table 6).

Tonga Formation

Sample 191-17A is a St-And-Grt-Sil-Bt schist with accessory muscovite and ilmenite that was sampled within the contact aureole of the Beckler Peak pluton (Figure 2, Figure 9A and B) previously mapped as contact metamorphic or M2 by Jensen et al. (2009). The sample contains two foliations. The initial foliation inferred to represent M1 is preserved in andalusite as aligned quartz and biotite inclusions. The dominant foliation inferred to represent M2-M3 is defined by sillimanite, biotite, plagioclase feldspar, and quartz (Figure 10A). Staurolite overgrows and locally is wrapped by the M2-M3 foliation (Figure 10A). Relict andalusite is wrapped by the foliation M2-M3 and partially replaced by quartz, biotite, sillimanite, and occasionally staurolite (Figure 10A). Garnet is inclusion free and is wrapped by the foliation. Individual grains have irregular grain boundaries suggesting possible resorption (Figure 10A).

Sample 191-17b is a St-And-Grt-Bt schist with accessory muscovite and ilmenite that was sampled within the contact aureole of the Beckler Peak pluton (Figure 2, Figure 9A) mapped as contact metamorphic or M2 by Jensen et al. (2009). The sample contains two foliations. The initial foliation inferred to represent M1 is preserved in andalusite as aligned quartz and biotite inclusions. The dominant foliation inferred to represent M2-M3 is defined by biotite, plagioclase feldspar, and quartz (Figure 10B). Staurolite overgrows and locally is wrapped by the foliation. Relict andalusite is wrapped by the M2-M3 foliation and partially replaced by quartz, biotite, and occasionally staurolite (Figure 10B). Garnet is wrapped by the foliation and in contact with andalusite. Individual grains have irregular grain boundaries suggesting possible resorption (Figure 10B). Adjacent to the garnet rim X_{Grs} concentrations increase, X_{Sps} concentrations level off, and X_{Pyr} concentrations decrease suggesting major element re-equilibration during retrograde metamorphism (Table 3 and Figure 11A, B). Garnet compositions with the highest X_{Mg} were paired with matrix biotite, plagioclase, staurolite, and muscovite. Calculated metamorphic conditions for this sample are 5.9±2.2 kilobar and 652±100°C (Table 6).

Sample 191-36 is a graphitic St-Grt-Bt schist with accessory muscovite, chlorite, and ilmenite (Figure 2, Figure 9C and D) mapped as a high pressure and temperature assemblage by Jensen et al. (2009). This sample has a single dominant foliation inferred to represent M3 is defined by graphite, biotite, plagioclase feldspar, and quartz (Figure 10C and D). Ilmenite occurs as acicular grains parallel and at high angle to the foliation and as small angular pieces within the foliation (Figure 9D). Staurolite is wrapped by and overgrows the foliation (Figure 10C and D). In places, staurolite preserves an internal foliation consistent with the main foliation (Figure 10C). Inclusions in staurolite include quartz, biotite, and garnet. Locally, staurolite is replaced by chlorite, biotite, and muscovite. Biotite occurs as porphyroblasts aligned with the foliation (Figure 10C and D). Euhedral garnet porphyroblasts are wrapped by the fabric and in some cases is contained as an inclusion in staurolite. Rare inclusions in garnet include quartz and biotite. Garnet zoning profiles display typical growth zoning with X_{Sps} decreasing from core to rim, X_{Pyr} and X_{Alm} increasing from core to rim, and X_{Grs} concentrations are relatively constant across the grain (Table 3 and Figure 11C, D). Adjacent to the garnet rim X_{Grs} concentrations decrease and X_{Pyr}-X_{Sps} concentrations level off, suggesting major element re-equilibration during retrograde metamorphism (Table 3 and Figure 11C, D). Garnet compositions with the highest X_{Mg} and lowest X_{Sps} were paired with matrix biotite, plagioclase, staurolite, muscovite, and with end member ilmenite. Calculated metamorphic conditions for this sample are 7.4±1.1 kilobar and 590±48°C (Table 6) similar to pressures reported by Duggan and Brown (1994).

In the Chiwaukum Schist, evidence of M1 metamorphism is preserved in as Grt-Crd-Bt±Amp assemblages recording temperatures between 600-750°C and pressures around 3 kilobars. M2 is restricted to the region directly adjacent to Mount Stuart Batholith and is preserved as Grt-And-Bt±Sil assemblages recording temperatures of 550°C and pressures around 4 kilobars. The final event in the Chiwaukum Schist, M3, is preserved as Grt-St-Bt±Ky±Sil in the region north and east of Mount Stuart Batholith recording temperatures between 600 and 700°C and pressures between 5.5 and 7.5 kilobars.

In the Tonga Formation, evidence of M1 metamorphism is poorly preserved with Grt-Chlorite assemblages being expected. Average pressure and temperature calculations likely do not record this event. M2 is restricted to the region directly adjacent to the Beckler Peak pluton and is preserved as Grt-And-Bt±Sil assemblages recording temperatures of ~650°C and pressures around 4-6 kilobars. The final event in the Tonga

Formation, M3, is preserved as Grt-St-Bt in the region north of the Beckler Peak pluton recording temperatures of 600°C and pressures of 7.4 kilobars.

Pseudosection Modeling

In order to further constrain the conditions of peak metamorphism and to determine the P-T conditions of initial garnet growth, isopleths constructed with garnet core compositions for the four dominant garnet endmembers (almandine, grossular, pyrope, and spessartine) from each sample were paired with a sample specific pseudosection to determine the pressure and temperature conditions of initial garnet growth, and the peak pressure and temperature conditions. In certain cases, these pseudosection estimates were compared with average pressure and temperature (AVPT) calculations to create a partial prograde P-T path. A pseudosection for Sample 191-05a was not modeled because the published amphibole solution models for Theriak-Domino were insufficient to model the observed assemblage (Diener and Powell, 2012). Quantitative garnet core compositions used for isopleth modeling are in Table 7. Bulk rock compositions used for modeling are in Table 8.

Chiwaukum Schist

Sample 191-46c has a peak metamorphic mineral assemblage of Grt-Crd-Bt with accessory Ilm and Chl. This minerology is predicted to be stable over a wide range from 550-725ºC and 1.0-5.0 kilobar (Figure 12A). Average pressure and temperature calculations for the equilibrium mineralogy overlap with the pseudosection estimate (Table 6 and Figure 12A). The garnet-in line occurs above 500 ºC at 6.0 kilobar, above 525 ºC at 4.0 kilobar, and above 525 ºC at 1.0 kilobar (Figure 12A). Garnet core isopleth compositions generally converge between 700-750ºC and 1.5-4.0 kilobar (Figure 12B) overlapping with highest temperature end of the predicted minerology. These temperatures are similar to those produced by Whitney (1992) for near by rocks. Garnet isopleths suggest growth initiated at or near peak temperature with a ~75 ºC decrease in temperature and an increase in pressure of ~1 kilobar required to move from the area defined by these isopleths to the predicted P and T range of the peak metamorphic assemblage and the average PT.

Sample 191-10a has the peak metamorphic mineral assemblage Chl-And-Grt-Bt and accessory muscovite and pyrite. This minerology is predicted to be stable at 550 ºC and 3.2 kilobar in zone 35 (Figure 13A). Average pressure and temperature calculations for the equilibrium minerology overlap with the pseudosection estimate (Table 6 and Figure 13A). The garnet-in line occurs above 550 ºC at 4.0-6.0 kilobar and above 1.5 kilobar at 550->700 ºC (Figure 13A). Garnet core isopleths constructed for the sample converge in two areas. Almandine, grossular, spessartine, and pyrope define a region near the lower limits of the garnet stability field between 550-625ºC and 3.0-5.5 kilobar and almandine, pyrope, and spessartine converge between 700-775 ºC and 2-3.5 kbar (Figure 13B). It is likely that garnet growth initiated in the lower temperature zone because the sample lacks cordierite and orthopyroxene predicted in the higher temperature convergence zone.

Sample 191-22a has the peak metamorphic mineral assemblage St-Grt-Sil-Bt with accessory muscovite. This minerology is predicted to be stable at 600-650 ºC and 4.0-6.5 kilobar (Figure 14A). Average pressure and temperature calculations for the equilibrium minerology overlap with the pseudosection estimate (Table 6 and Figure 14A). The garnet-in line occurs above 550 ºC at 4.0-6.0 kilobar, above 580 ºC at 5.5 kilobar, above 625 ºC at 6.0 kilobar, and above 650 ºC at 4.5 kilobar (Figure 14A). Garnet core isopleths constructed for the sample converge in the gray ellipse between 625ºC and 6.0 kilobar (Figure 14B). Garnet growth initiated at or near peak conditions. It is important to note that the garnet-in line is at higher pressure and temperatures with this sample than other samples.

Sample 191-08a has the peak metamorphic mineral assemblage St-Ky-Grt-Bt with accessory ilmenite and rutile. This minerology is predicted to be stable at 640 ºC and 7.0 kilobar in zone 32 (Figure 15A). Average pressure and temperature calculations for the equilibrium minerology overlap with the pseudosection estimate (Table 6 and Figure 15A). The garnet-in line occurs above 525 ºC at 5 kilobar, above 540 ºC at 3.0 kilobar, and above 600 ºC at 3.5 kilobar (Figure 15A). Garnet core isopleths constructed for the sample converge near the lower limits of the garnet stability field between 525-550ºC and 5.0-5.5 kilobar (Figure 15B). The data suggest an increase in temperature and pressure of ~100 ºC and ≤2.0 kilobar from initial garnet growth to peak PT conditions.

Tonga Formation

Sample 191-17b has the peak metamorphic mineral assemblage St-And-Grt-Bt with accessory muscovite and ilmenite. This minerology is predicted to be stable at 560-625 ºC and 4-5.5 kilobar in zone 13 (Figure 16A). Average pressure and temperature calculations for the equilibrium minerology have large uncertainties and overlap with the pseudosection estimate (Table 6 and Figure 16A). The garnet-in line occurs above 400 ºC at 2.0 kilobar, above 450 ºC at 4.0 kilobar, and above 480ºC at 3.0 kilobar (Figure 16A). Garnet core isopleths constructed for the sample converge at 600ºC and 4.5 kilobar (Figure 16B). Garnet growth initiated at or near peak conditions. It is important to note that the garnet stability field exists at lower pressures and temperatures than other samples.

Sample 191-36 has the peak metamorphic mineral assemblage St-Grt-Bt schist with accessory muscovite, chlorite, tourmaline, and ilmenite. This minerology is predicted to be stable at stable at 575-625ºC and 4.0-6.5 kilobar (Figure 17A). Average pressure and temperature calculations for the equilibrium minerology predict a higher pressure and temperature for peak metamorphism than the pseudosection estimate (Table 6 and Figure 17A). The garnet-in line occurs above 475 ºC at 7.0 kilobar, above 525 ºC at 2.0 kilobar, and above 600ºC at 3.5 kilobar (Figure 17A). Garnet core isopleths constructed for the sample converge over a wide area near the lower limits of the garnet stability field between 550-575ºC and 3.0-5.0 kilobar (Figure 17B). An increase in temperature and pressure of ~50ºC and ~2.0 kilobar would be needed to move from the area defined by these isopleths to the predicted P and T range of the peak metamorphic assemblage.

In summary, M1 garnet growth initiated in the southern Chiwaukum Schist and Tonga formation at pressures and temperatures between 3.0 and 4.0 kilobar and between 550 and 650ºC. The central and northern region around Mount Stuart batholith saw garnet growth at pressures between 3 and 6 kilobar at ~650ºC probably related to M2 and M3.

Garnet Lu-Hf and Sm-Nd Geochronology

Seven Lu-Hf and Sm-Nd isochrons, comprised primarily of four garnet and two garnet-free whole rock fractions, were constructed for five samples from across the Chiwaukum Schist and two samples from the Tonga Formation. To improve the precision of the age regression, one or more fractions (garnet or garnet free whole rock) have been excluded from the final isochrons (Lu-Hf, Sm-Nd, or both) for several samples marked by a cross in Table 9 and 10. These fractions were not utilized in the final isochron due to anomalous isotopic ratios that show they are not in equilibrium with the rest of the sample which may be due to REE rich inclusions, errors in the separation process, or errors in analysis.

The Hf-Nd isotope data are summarized in Table 9 and 10. Present day isotope ratios are given with their in-run errors (2σ standard error). Epsilon hafnium and neodymium values for whole rock and garnet fractions are calculated at present day and at age produced by the isochron. Epsilon hafnium and neodymium values for isochron y axis intercepts are calculated using the equation (((intercept $^{176}Hf/^{177}Hf$ or $^{143}Nd/^{144}Nd)_{sample}$)/($^{176}Hf/^{177}Hf$ $^{143}Nd/^{144}Nd)_{chur}$)-1)*10000 for the epsilon value and (((intercept error $^{176}Hf/^{177}Hf$ or $^{143}Nd/^{144}Nd)_{sample}$)/($^{176}Hf/^{177}Hf$ $^{143}Nd/^{144}Nd)_{chur}$))*10000 and provided in Table 12. The uncertainties on the $^{176}Hf/^{177}Hf$ and $^{143}Nd/^{144}Nd$ ratios given in Table 9 and 10 are the internal reproducibility's of the Hf and Nd isotope measurements and in run standards (2σ standard error) as calculated within each run.

The analyzed garnets are characterized by variable Lu and Hf concentrations, typically high Lu (~5 and ~16 ppm) and low Hf (~0.1 and ~1 ppm) with typical sample Lu variations between fractions not exceeding 5 ppm and typical Hf variations between fractions not exceeding 0.3 ppm for a given sample. The high Lu and relatively low Hf concentrations of many garnet fractions are reflected in $^{176}Lu/^{177}Hf$ ratios as high as ~15.2 (191-22a); garnet fractions with relatively low Lu and higher Hf concentrations displayed significantly lower $^{176}Lu/^{177}Hf$ ratios of ~1.2 (191-10a).

The garnets are also characterized by variable abundances of Sm (~0.80-6.40 ppm) and Nd (~0.56-22.51 ppm) with typical sample Sm variations not exceeding 2 ppm and typical Nd variations not exceeding 1.5 ppm between garnet fractions for a given sample. $^{147}Sm/^{144}Nd$ ratios for all samples do not exceed 2.0 with most between 0.6 and 1.1. Garnet fractions from several samples (191-05a, 191-08a, 191-46c, and 191-10a) have low $^{147}Sm/^{144}Nd$ ratios leading to large uncertainties in the age calculations as in run calculated $^{143}Nd/^{144}Nd$ errors have a greater effect.

Chiwaukum Schist

Sample 191-05a garnet trace element (Figure 18A) zoning indicates that two generations of garnet growth may be present within each grain (high central Lu peak and flat rim), that may cause the isotopic scatter between garnet points. Lu/Hf ratios range from 0-3.0 with individual garnet points ranging from 1.7-2.6 (Table 9 and Figure 19A). The Lu-Hf isochron for this sample displays two sets of Lu-Hf data. One set displays nonlinear isotopic scatter between the oldest garnet fractions (G1-G4) with notable scatter in the $^{176}Lu/^{177}Hf$ ratio on the x-axis and limited scatter in the $^{176}Hf/^{177}Hf$ ratio on the y-axis (Figure 19A). Of these garnet separates, the oldest garnet separate (G3) gives a two-point garnet-whole rock isochron date of ~123 Ma and the youngest separate (G4) gives a two-point garnet-whole rock isochron date of 99 Ma. The other set give a four point garnet-whole rock Lu-Hf isochron date of 93.11±3.6 Ma with a MSWD of 9 (Figure 19A). Sm-Nd ratios range from 0-0.35 with individual garnet points ranging from 0.17-0.35 (Table 10 and Figure 19B). A seven-point Sm-Nd isochron for the same sample gives a date of 106.2±22 Ma with a MSWD of 3.4 (Figure 19B).

Sample 191-46c garnet trace element (Figure18B) zoning profile is relatively uniform with minor elemental variations in concentration of Sm, Nd, Lu, and Hf. The Lu-Hf isochron for this sample displays two sets of Lu-Hf data. One set displays nonlinear isotopic scatter between garnet separates G1, G2, and G4 with notable scatter in the $^{176}Lu/^{177}Hf$ ratio on x-axis and limited scatter in the $^{176}Hf/^{177}Hf$ ratio on the y-axis (Table 9 and Figure 19A). The oldest garnet separate (G1) gives a two-point garnet-whole rock isochron date of ~133 Ma and the youngest separate(G4) gives a two-point garnet-whole rock isochron date of 95 Ma. The other set give a five-point isochron (four garnets and one whole rock) date of 93.2±3.4 with a MSWD of 23. The Sm-Nd ratios range from 0-0.30 with individual garnet points ranging from 0.25-0.30 (Table 10 and Figure 19D). A five-point Sm-Nd isochron for the same sample gives a date of 90±21 Ma with a MSWD of 0.69 (Figure 19D).

Sample 191-10a garnet trace element profile shows increasing concentrations of Sm, Nd, and Hf from rim to core and decreasing Lu concentrations from rim to core (Figure 18C). Lu/Hf ratios range from 0-1.3 with individual garnet points ranging from 0.9-1.3 (Table 9 and Figure 19E). A six-point Lu-Hf isochron gives an age of 90.1±5.3 Ma with a MSWD of 3.3 (Figure 19I). Sm-Nd ratios range from 0-0.6 with individual garnet points ranging from 0.25-0.6 (Table 10 and Figure 19E). A six-point Sm-Nd isochron for the same sample gives a date of 95±10 Ma with a MSWD of 1.08 (Figure 19F).

Sample 191-22a garnet trace element zoning profile shows a broad central peak and two shallower shoulder peaks in Lu concentration, along with slightly elevated Sm, Nd, and Hf concentrations near the core that decrease toward the rim (Figure 18D). Lu/Hf ratios range from 0-16 with individual garnet points ranging from 12-16 (Table 9 and

Figure 19G). A five-point Lu-Hf isochron gives an age of 90.3±2.3 Ma with a MSWD of 7.8 (Figure 19G). This sample has a single isotopically dissimilar garnet point that gives a two-point garnet-whole rock isochron date of 95 Ma. Sm-Nd ratios range from 0-1.8 with individual garnet points ranging from 0.4-1.8 (Table 10 and Figure 19H). A six-point Sm-Nd isochron for the same sample gives a date of 89.5±3 Ma with a MSWD of 1.10 (Figure 19H).

Sample 191-08a garnet trace element zoning profile shows a broad central peak and two shallower shoulder peaks in Lu concentration, along with depressed Sm and Hf concentrations near the core, which steadily increase toward the rim of the garnet (Figure 18E). Lu/Hf ratios range from 0-11.5 with individual garnet points ranging from 5-11.5 (Table 9 and Figure 19I). A five-point Lu-Hf isochron gives an age of 94.1±5.6 Ma with a MSWD of 38 (Figure 19I). This sample has a single isotopically dissimilar garnet point that gives a two-point garnet-whole rock isochron date of 162 Ma. Sm-Nd ratios range from 0-0.3 with individual garnet points ranging from 0.22-0.3 (Table 10 and Figure 19J). A six-point Sm-Nd isochron for the same sample gives a date of 86±14 Ma with a MSWD of 0.12 (Figure 19J).

Tonga Formation

Sample 191-17b garnet trace element zoning profile shows the garnets are broadly unzoned with respect to Lu and Sm (Figure 20A). However, Nd and Hf concentrations decrease from core to rim. Lu/Hf ratios range from 0-3.5 with individual garnet points ranging from 2.25-3.5 (Table 9 and Figure 21A). A five-point Lu-Hf isochron gives an age of 118.7±5 Ma with a MSWD of 4.2 (Figure 21A). This sample has a single isotopically dissimilar garnet point that gives a two-point garnet-whole rock isochron date of 139 Ma.

Sm-Nd ratios range from 0-0.9 with individual garnet points ranging from 0.5-0.8 (Table 10 and Figure 21B). A six-point Sm-Nd isochron for the same sample gives a date of 88.3±3.3 Ma with a MSWD of 1.8 (Figure 21B).

Sample 191-36 garnet trace element (Figure 20B) zoning is relatively flat from rim to rim. Lu/Hf ratios range from 0-12 with individual garnet points ranging from 9-12 (Table 9 and Figure 21C). A four-point Lu-Hf isochron gives an age of 103±4.8 Ma with a MSWD of 7.8 (Figure 21C). This sample has four isotopically dissimilar garnet points that give two-point garnet-whole rock isochron dates of ~121, ~107, ~100, and~94 Ma. Sm-Nd ratios range from 0-1.3 with individual garnet points ranging from 1.0-1.3 (Table 10 and Figure 21D). A five-point Sm-Nd isochron for the same sample gives a date of 91.1±2.3 Ma and a MSWD of 1.5 (Figure 21D).

DISCUSSION

Geochronology and the Wenatchee block

Data from this study and published data allow for a better understanding of the metamorphic and deformational history of the Wenatchee block. To better understand the Wenatchee block, these new and existing ages must be addressed spatially and chronologically allowing any patterns in the data to become evident.

M1 Metamorphism

Chiwaukum Schist

In the Chiwaukum Schist, the timing of M1 is constrained by the maximum depositional age of the Chiwaukum Schist/Tonga Formation of ~120 (Brown and Gehrels 2007; Paterson 2014; Paterson 2020 *personal communication),* several existing Sm-Nd low-precision isochrons of Magloughlin (1993), Chase et al (1998), and Holler (2013) (Figure 22), a series of two-point Lu-Hf isochrons from (Figure 19A, C and Figure 22 (the gray squares)), and a new-low precision Sm-Nd isochron (Figure 19B and Figure 22). The high degree of scatter between the individual garnet points on both Lu-Hf isochrons (Figure 19 A and C) can be interpreted either as an error in sample processing (a spike-sample equilibration issue or unforeseen preferential dissolution of Lu rich phases) or that these rocks preserve multiple metamorphic events with the oldest event (M1) occurring directly after host rock incorporation into the arc ~120 and a younger event centered around the time of M2 or M3. If the latter interpretation was true, then it would be expected that all Sm-Nd isochrons, due to the lower Sm-Nd closure temperature, would be reset to a younger age along with the Lu-Hf. This is not evident with the present data. Even with this discrepancy, it cannot be avoided that both Lu-Hf samples that have these suspect old grains also form reasonable multi-point isochrons through the youngest points centered around a 93 Ma event and likely represent a M2 event, probably related to the intrusion of the 96-92 Ma Mount Stuart Batholith. Optically in thin section, these M1 rocks often show evidence for multiple fabrics and sometimes multiple metamorphic events, including biotite inclusion halos in sample 191-04 (Figure 7B), andalusite breakdown reactions in sample 191-03 (Figure 7A), pre-to syn- tectonic garnet followed by post-tectonic cummingtonite-grunerite amphibole/ refolded folds within sample 191-05a (Figure 7B, C), and pre-tectonic garnet and two generations of cordierite in sample 191-46c (Figure 7E). The fact that the Sm-Nd isochrons from samples 191-05a and 191-46c (Figure 19B, D) overlap with the 120-110 Ma timing estimate of M1, the flat trace element zoning on the rim of sample 191-05a (Figure 18A) and the erratic trace element zoning of sample 191-46c (Figure 18B) suggest two events are preserved within a vast majority of M1 samples in the Chiwaukum Schist with the younger event drastically affecting preservation of the oldest event.

Tonga Formation

In the Tonga Formation, M1 is better constrained and consistent with the timing estimate of M1 in the Chiwaukum Schist. The timing of M1 is constrained by a five point ~119 Ma Lu-Hf isochron from sample 191-17b collected near the ~92 Ma Beckler Peak Pluton and a four point ~103 Ma Lu-Hf isochron from sample 191-36 collected 15 km north of the Beckler Peak pluton near the location of the \ detrital zircon sample of Brown and Gehrels (2007) (Figure1, Figure 2, and Figure 21A, C). Four of the six garnet separates from sample 191-36 are isotopically dissimilar from the rest with the most and least radiogenic garnet separates producing two-point isochron ages of ~121 and ~94 Ma respectively (Figure 21C). This scatter is similar to the scatter preserved within the M1 Chiwaukum Schist Lu-Hf samples as both only significantly vary in their Lu/Hf rations with little variation in the Hf/Hf ratios. Similar to the M1 samples in the Chiwaukum Schist, this 103 Lu-Hf age from the Tonga Formation can also be interpreted as a mixed age with the oldest separate preserving an older event, probably M1, the youngest separates preserving a younger age, probably M2-M3, and the middle two separates preserving some mix of the older and younger events. The age from the Lu-Hf isochron for sample 191-17b and the oldest garnet separate from sample 191-36 are interpreted to date M1 in the Tonga (Figure 21A, C). The interpretation that the garnets dated here date M1 is bolstered texturally by the fact that the garnets in both samples are wrapped by the final fabrics. Garnet isopleths from sample 191-36 converge between 550-575ºC and 3.0-5.0 kilobar and indicate an increase in pressure and temperature from the initiation of garnet growth at similar pressure and temperatures of M1 in the Chiwaukum Schist to the final observed pressure and temperature conditions similar to M3 of >6.5 kilobar and >600°C.

M2 Metamorphism

The narrow time window between M2 and M3 makes it difficult to separate the final two metamorphic events from each other to within an error of ±3 myr, however, the rocks can be categorized into two groups based on mineral composition. M2 is defined as Buchan style metamorphism (low-pressure and high-temperature) and is distinguished by andalusite-sillimanite assemblages in the contact aureole of the Mount Stuart batholith and Beckler Peak pluton. M3 is defined as Barrovian style metamorphism (high-pressure and high-temperature) with typical assemblages of garnet, staurolite, kyanite, and sometimes sillimanite being widespread. Often the M3 assemblages overprint M2 assemblages.

Chiwaukum Schist

In the Chiwaukum Schist, M2 metamorphism was directly related to the intrusion of the Mount Stuart batholith. M2 is bracketed to have occurred between 96 and 92 Ma by igneous zircon ages from the Mount Stuart batholith (Matzel et al., 2006). Based on sample 191-10a's six-point Lu-Hf isochron of 90.1±5.3 Ma and five-point Sm-Nd isochron of 95±10 Ma (Figure 19E, F) garnet growth is interpreted to have initiated adjacent to the central and northern portions of the Mount Stuart batholith during the latter half of M2 and outlasted andalusite growth (Figure 7I) congruent with nearby igneous ages (Matzel et al. (2006)) and contrary to the arguments of Evans and Davidson (1999) who claim garnet growth during M2 was not widespread.

M2 metamorphism near Tunnel creek (sample 191-10a and b) probably began around 96 Ma at pressures just below the garnet stability field in the andalusite stability field modeled for the outcrop (Figure13A zone 34) at 550°C and 3 kilobars. A slight increase in pressure/temperature would allow this assemblage to cross the into the garnet stability field and end in the garnet-biotite-andalusite-staurolite stability field (Figure 13A zone 40). Evans and Davidson (1999) note the presence of staurolite in micro veinlets from this locality making this estimate plausible.

M3 Metamorphism

Chiwaukum Schist

In the Chiwaukum Schist, the timing of M3 is bracketed by new Lu Hf and new and existing Sm-Nd garnet isochrons that range in age between 91 and 86 Ma. Directly north of the Mount Stuart batholith, near Heather lake, Stowell and Tinkham (2003) developed a prograde garnet growth path using a pseudosection and garnet core isopleths they modeled for sample 96NC67. Stowell and Tinkham's (2003) pseudosection and garnet core isopleths produced a partial prograde metamorphic path beginning with initiation of garnet growth at 4.8 kilobar and 593°C and ending with peak metamorphism at 6.0 kilobar and 668°C. Stowell and Tinkham (2003) claim that their 86 Ma Sm-Nd garnet age dates initiation of garnet growth at 4.8 kilobar and 593°C rather than peak metamorphism or cooling from peak metamorphic conditions. To check this conclusion sample 191-22a was collected near where sample 96NC67 was collected. The new Lu-Hf and Sm-Nd isochrons allow Stowell and Tinkham's (2003) 86 Ma Sm-Nd garnet isochron age to be reinterpreted as dating cooling from peak conditions with garnet growth initiating at 91 Ma based on the new Lu-Hf age however, the pseudosection and garnet core isopleths modeled with these new ages does not confirm Stowell and Tinkham's (2003) determination of pressure and temperature of garnet growth (Figure 14).

The pseudosection and garnet core isopleths for sample 191-22a modeled in conjunction with the new ages differs significantly from the path proposed by Stowell and Tinkham (2003) (Figure 14). The final pressure and temperature conditions for the sample are reasonable at 6.2 kilobar and 625°C, however the isopleths fail to define a region significantly different than the final pressure and temperature zone. This difference causes the garnet stability field to be dramatically shifted to higher pressures and temperatures and contain an oddly shaped garnet free zone within Stowell and Tinkham's (2003) garnet stability field (Figure 14A). This difference is interpreted to reflect the possibility that the bulk rock sample used in the pseudosection for sample 191-22a (Figure 14) is not representative of the bulk rock composition of the entire rock causing large differences in the final pseudosection.

The possibility exists that garnet growth in the area dominated by the M3 event occurred prior to M3 burial of the region. The presence of a slightly isotopically older garnet fraction (two-point isochron age of ~95 Ma) (Figure 19E) and complex trace element zoning (Figure 18D) could be interpreted as the sample was affected by either M1 (unlikely) or a distal portion of M2. If the final pressure and temperature estimates of Stowell and Tinkham (2003) are correct then the garnet Sm-Nd system could have been reset from an earlier event however these temperatures are likely not high enough to affect the Lu-Hf system.

The Lu-Hf isochron, pseudosection, and garnet zoning characteristics for sample 191-08a point toward preservation of an earlier event, ~94 Ma, to the east of Mount Stuart batholith however precise determination is difficult with the associated 5 million-year error. Calculated pressures and temperatures for this sample indicate the sample experienced pressures and temperatures greater than 7 kilobar and 650°C for the peak kyanite bearing minerology plotting around 6.5 kilobar and 650°C on the sample pseudosection (Figure 15A). These pressure and temperature conditions and the Sm-Nd isochron (Figure 19J) are interpreted to coincide with M3 metamorphism, however, the Lu-Hf isochron, garnet core isopleths, and major/ trace element zoning profiles suggest an earlier event is preserved (Figure 8I and J, Figure 15B, Figure 18E). Garnet core isopleths plot near the lower limits of the garnet stability field roughly 5.5 kilobar and 550°C (Figure 15B zone 13). The Lu-Hf isochron and trace element zoning profile for this sample (Figure 19I, Figure 18E) suggests that the Lu-Hf age is biased toward the garnet core and that the Lu-Hf age dates the timing of the garnet core growth during M2 The isotopic dissimilarity between the garnet separates and the complex trace element zoning characteristics make an exact determination of the timing of initiation of garnet growth in this region difficult.

Tonga Formation

In the Tonga Formation, M2 and M3 are geochronologically indistinguishable from each other (spanning the same time frame from 92-88 Ma) however, M2 and M3 can be distinguished from each other based on assemblage. Like the Chiwaukum Schist, the index minerals of these two events differ. M2, similar to M2 in the Chiwaukum Schist, is marked by Buchan style metamorphism (low-pressure and high-temperature) defined by the presence garnet-biotite-andalusite-sillimanite assemblages in the contact aureole of the Beckler Peak Pluton (Figure 2, Figure 4, and Figure 10A, B). M3 in the Tonga

Formation differs from the Chiwaukum Schist with the lack of a high-pressure high-temperature aluminosilicate and the presence of garnet-biotite-staurolite assemblages (Figure 2, Figure 4, Figure 10C, D) and reported by Duggan (1992).

Beckler Peak Pluton Contact Aureole

In the Tonga Formation, M2 metamorphism of 191-17b adjacent to Beckler Peak pluton occurred in the andalusite stability field around 575°C and 3.5 kilobars at the synchronous with the intrusion of the Beckler Peak pluton at ~92 Ma (Figure 16A). Directly following intrusion, pressure increased at least 0.5 kilobar causing the M2 rocks to pass into the staurolite stability field, out of the andalusite stability field, and reach the peak mineral assemblage of garnet-biotite-staurolite (Figure 16A zone 13) seen as staurolite-biotite assemblages that replace earlier andalusite. These later higher-pressure assemblages and increase in pressure are interpreted as evidence of M3 with peak minerology occurring before the 88.3 Ma Sm-Nd age of sample 191-17b.

The Sm-Nd age for sample 191-17b is interpreted to represent a completely isotopically reset system and cooling age from peak M3 conditions. M1 metamorphism caused garnet growth at roughly 119 Ma. Depending on the cooling rate of the system an M1 Sm-Nd age would likely be slightly younger than the 119 Lu-Hf age. The intrusion temperature of the Beckler Peak pluton (~750°C) and subsequent burial caused the host rock to heat to at least 600°C producing changes in mineralogy noted in the thin section and reset the garnet Sm-Nd system while leaving the M1 Lu-Hf system intact.

Northern Tonga Formation

M3 metamorphism in the northern region occurred at pressures greater than 6 kilobar and temperatures greater than 600°C bracketed by a five-point Sm-Nd isochron age of ~91 Ma for sample 191-36 (Figure 21D). Regionally this metamorphic event is defined by staurolite after garnet (Figure 10C, D). Garnet core isopleths indicate that garnet growth initiated at pressures and temperatures of 3.5 kilobar and 525°C during M1 metamorphism signified by a complex Lu-Hf iscochron for a garnet-chlorite-white mica assemblage for sample 191-36 (discussed previously) (Figure 17A). A pressure and temperature increase of at least 1 kilobar and 50°C would have been sufficient for regional staurolite growth (Figure 17A zone 13). This increase in pressure and temperature and change in mineralogy is interpreted as M3 metamorphism.

The Sm-Nd age for sample 191-36 is interpreted to represent a completely isotopically reset system and cooling age from peak conditions. M3 related pressure and temperature changes are interpreted to have caused the Sm-Nd system to fully re-equilibrate (similar to what is seen with sample 191-17b) and the Sm-Nd age represents cooling from peak M3 metamorphic conditions.

Metamorphic evolution of the Wenatchee block

Previously existing M1 Sm-Nd ages are published and cited to a series of conference abstracts and dissertations (e.g., see Evans and Davidson (1999) for discussion) however, this data was not peer reviewed. Due to the lack of peer reviewed data, in Figure 22 I have assigned the pressure conditions for these ages using the calculated pressures from samples with similar ages (Table 11). The imprecision as a result of the complex isochrons presented here has led to a range in estimates for the timing of M1, however, the range in ages is interpreted to result from either a prolonged metamorphic event or the ages are mixed ages between M1 and a younger M2 or M3 events (represented by the gray squares in Figure 22).

With this non-peer reviewed data in mind, a clearer story of the metamorphic evolution of the Wenatchee block begins to unfold. In the Chiwaukum Schist and Tonga Formation M1 new and existing Sm-Nd isochrons from the Chiwaukum Schist and a Lu-Hf isochron from the Tonga Formation suggest M1 was garnet grade and initiated between 120 and 110 Ma at pressures and temperatures between 3 and 4.5 kilobar and 600-650°C in the Chiwaukum Schist and ~4.5 kilobar and 575°C in the Tonga Formation (Figure 12, Figure 17, and Figure 22). This event was restricted to the southern Chiwaukum Schist in the area surrounding Icicle Canyon and at least the central to northern Tonga Formation (data is insufficient to tie M1 to the entire Tonga Formation) (Figure 2). A similarly aged event may also be preserved near the Wenatchee ridge orthogneiss to the NW however Holler (2013) suggests there may be issues with those ages. This assessment of M1 does not exclude the idea that in other areas in the Chiwaukum Schist garnet growth could have occurred synchronous with M1 however data to support that claim is sparse.

Regional M2 metamorphism is the most well constrained event in both the Chiwaukum Schist and Tonga Formation because the ages of plutons causing the contact metamorphism are generally well constrained (Matzel et al. (2006)). In the Chiwaukum Schist, M2 initiated with a biotite-chlorite-andalusite assemblage. The Tonga Formation differs only slightly from this as the region had already experienced garnet grade metamorphism throughout the area affected by igneous activity. As M2 progressed in the both the Chiwaukum Schist and Tonga Formation a slight pressure/temperature increase caused contact metamorphic samples to cross into the sillimanite - staurolite stability field and partially replace andalusite in the Tonga Formation (Figure 10A) and the initiation of post andalusite garnet growth (Figure 7I). This increase may have been related to thermal relaxation from igneous activity or the beginning of M3 burial.

The timing of M3 metamorphism is constrained by new and existing high temperature ages plotting in a 5 million year window from 91 Ma to 86 Ma with pressures and temperatures ranging from 6-10 kilobar and 600-700°C in both the Chiwaukum Schist and Tonga Formation (Figure 22). The Lu-Hf isochron for sample 191-22a dates initiation of garnet growth around 91-90 Ma and Sm-Nd ages of 91-86 Ma followed by K-Ar Ar-Ar hornblende and mica ages track cooling to ~320°C from ≥650°C peak conditions by 84 Ma(Figure 5A and B) (e.g. Yeats and Engels, 1971; Tabor et al., 1989; Evans and Davidson, 1999; Stowell and Tinkham, 2003; Stowell et al., 2011).

CONCLUSIONS

Even though not all the data collected as part of this study is definitive in terms of timing or metamorphic conditions, analyzing it in conjunction with existing data allows for a clearer picture to be painted for the history of the region. The Wenatchee Block of the Cascades Crystalline Core contains evidence for three distinct metamorphic events. M1 is preserved in the southern Chiwaukum Schist and across the Tonga Formation as garnet – biotite – chlorite ± cordierite ± amphibole assemblages that formed approximately 120 to 110 Ma. In the Chiwaukum Schist, M2 occurred synchronous to the intrusion of the Mount Stuart batholith however local garnet growth did not occur until syn to post local igneous activity and post andalusite growth. In the Tonga Formation, initial M2 andalusite growth was followed by replacement by muscovite (reported by Duggan (1992)), staurolite, and occasionally sillimanite. M3 in both the Chiwaukum Schist and Tonga Formation is observed as an increase in pressure and temperature syn to post igneous activity (i.e. the Mount Stuart batholith and Beckler Peak pluton) likely related to a continuation of igneous activity at a shallow level in the crust. this period of rapid burial was followed by rapid cooling and possible exhumation beginning between 88 and 86 Ma around 650°C and cooling through the Ar-Ar closure temperature of biotite, roughly 320°C by 84 Ma. This new data adds to the story of the Wenatchee block and the Cascades Crystalline core however it fails to answer all of the questions. It is crucial for future workers to continue to implement new techniques to answer these questions for the Cascades Crystalline Core and orogenic belts worldwide.

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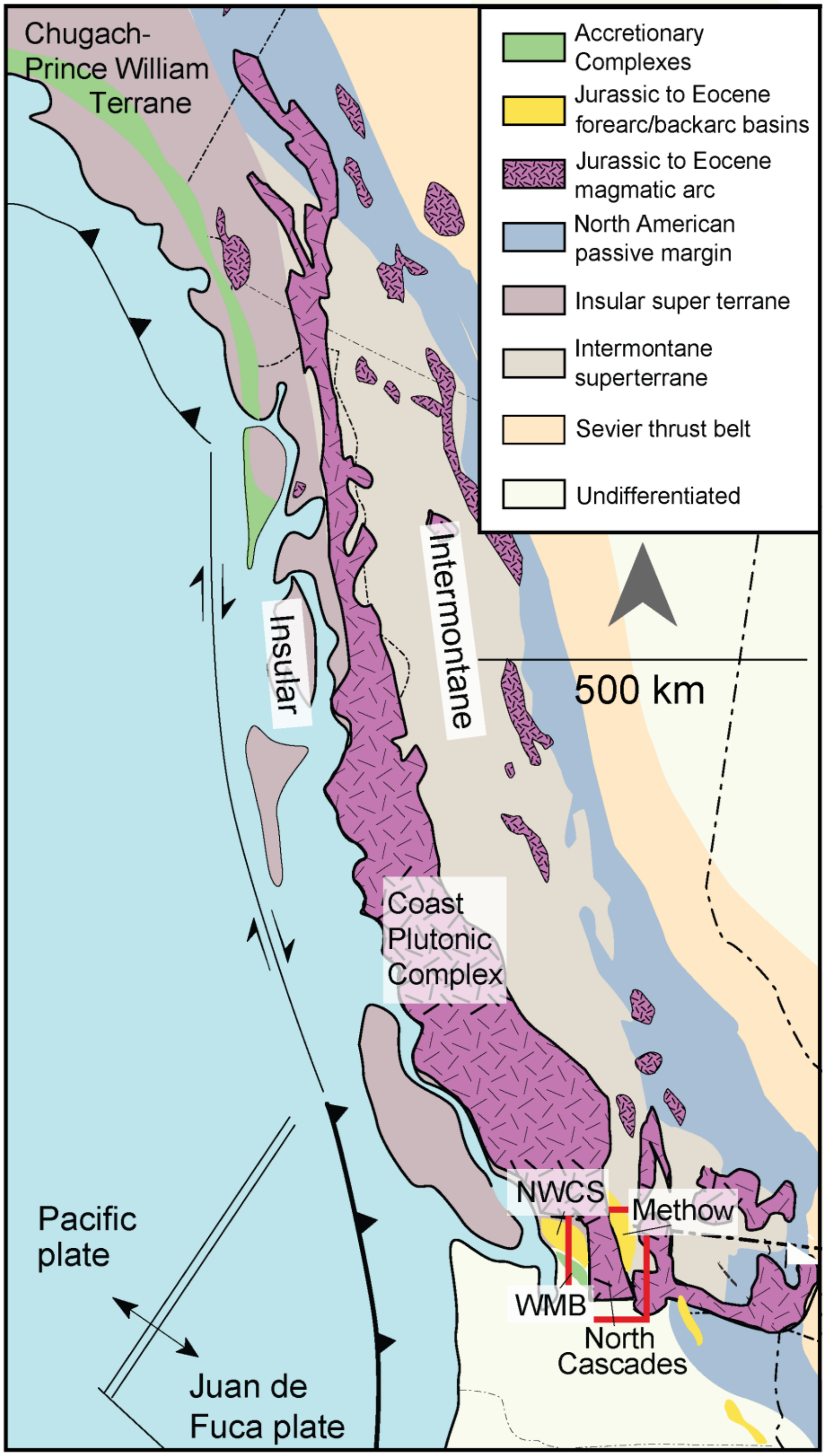


Chugach-
Prince William
Terrane
Accretionary
Complexes
Jurassic to Eocene
forearc/backarc basins
Jurassic to Eocene
magmatic arc
North American
passive margin
Insular super terrane
Intermontane
superterrane
Sevier thrust belt
Undifferentiated
Intermontane
Insular
500 km
Coast
Plutonic
Complex
NWCS
Methow
WMB
North
Cascades
Pacific
plate
Juan de
Fuca plate

Figure 1.

Generalized geologic map of western North America showing major geologic terranes and their relationship to each other. Note the Cascades Crystalline Core outlined in the red box. Modified from Sauer et al. (2017). NWCS-Northwest Cascade System; WMB-Western Mélange Belt.

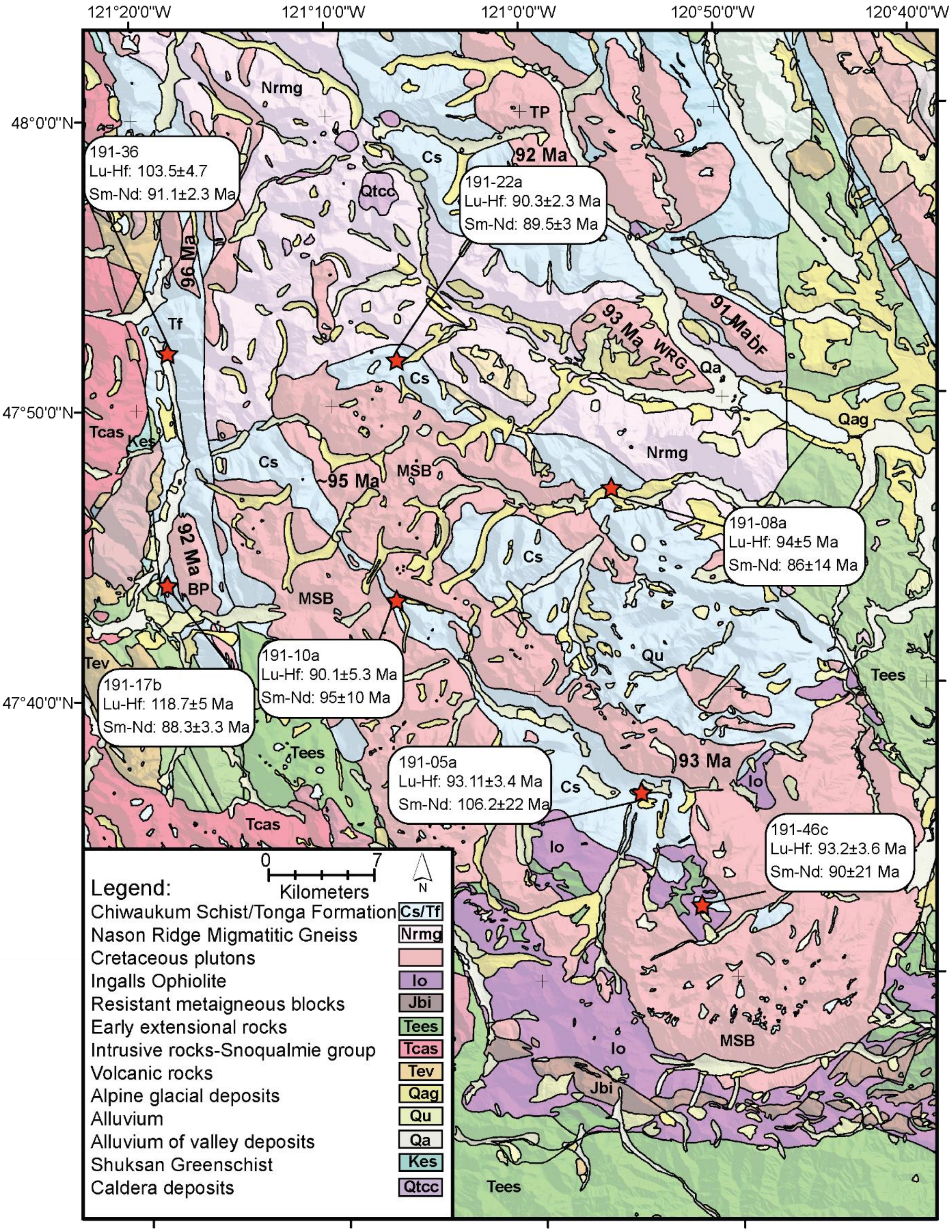

121°20'0"W
121°10'0"W
121°0'0"W
120°50'0"W
120°40'0"W
48°0'0"N
47°50'0"N
47°40'0"N
191-36
Lu-Hf: 103.5±4.7
Sm-Nd: 91.1±2.3 Ma
191-22a
Lu-Hf: 90.3±2.3 Ma
Sm-Nd: 89.5±3 Ma
191-08a
Lu-Hf: 94±5 Ma
Sm-Nd: 86±14 Ma
191-10a
Lu-Hf: 90.1±5.3 Ma
Sm-Nd: 95±10 Ma
191-17b
Lu-Hf: 118.7±5 Ma
Sm-Nd: 88.3±3.3 Ma
191-05a
Lu-Hf: 93.11±3.4 Ma
Sm-Nd: 106.2±22 Ma
191-46c
Lu-Hf: 93.2±3.6 Ma
Sm-Nd: 90±21 Ma
Nrmg
TP
92 Ma
Cs
Qtcc
96 Ma
Tf
93 Ma
WRG
91 Ma DF
Qa
Qag
Tcas
Kes
~95 Ma
MSB
92 Ma
BP
Qu
Tev
Tees
Io
Jbi
Legend:
0
7
Kilometers
N
Chiwaukum Schist/Tonga Formation Cs/Tf
Nason Ridge Migmatitic Gneiss Nrmg
Cretaceous plutons
Ingalls Ophiolite Io
Resistant metaigneous blocks Jbi
Early extensional rocks Tees
Intrusive rocks-Snoqualmie group Tcas
Volcanic rocks Tev
Alpine glacial deposits Qag
Alluvium Qu
Alluvium of valley deposits Qa
Shuksan Greenschist Kes
Caldera deposits Qtcc

Figure 2

Geologic map of the southern Wenatchee block modified from Haugerud and Tabor (2009). Samples dated as part of this study are marked with orange stars and the ages of the samples are included, uncertainty is reported at 2-sigma. MSB- Mount Stuart Batholith; BP- Beckler Peak pluton; WRG – Wetatchee Ridge Orthogneiss; DF – Dirty Face pluton; TP Ten Peak pluton; NRMG – Nason Ridge Migmatitic Gneiss.

Metamorphic Event	Transposition/ Deformation Cycle	Cause	Age	Porphyroblasts	P-T Estimates
	1	?	143-100 Ma	Biotite,	?
1	2	NE-SW Contraction	Pre 96 Ma	Hornblende, Biotite, Cordierite	Lower Amphibolite 2-4 Kb
	3	Windy Pass Thrusting	Pre 93 Ma	Hornblende	Lower Amphibolite 2-4 Kb
2	4	Pluton Emplacement	96-92 Ma	Cordierite, Andalusite, Sillimanite	550-725 C 3-5 Kb
3	5	NE-SW Contraction, Burial	93-85 Ma	Staurolite, Kyanite, Sillimanite	550-725 C 5-8 Kb

Figure 3

Summary of recognized metamorphic events and transposition cycles in the Chiwaukum schist after Paterson et al. (1994) and updated by Stowell and Tinkham (2003). M1 Age range based on ages from Magloughlin (1993) and Chase (1998). Note uncertainty with earliest events.

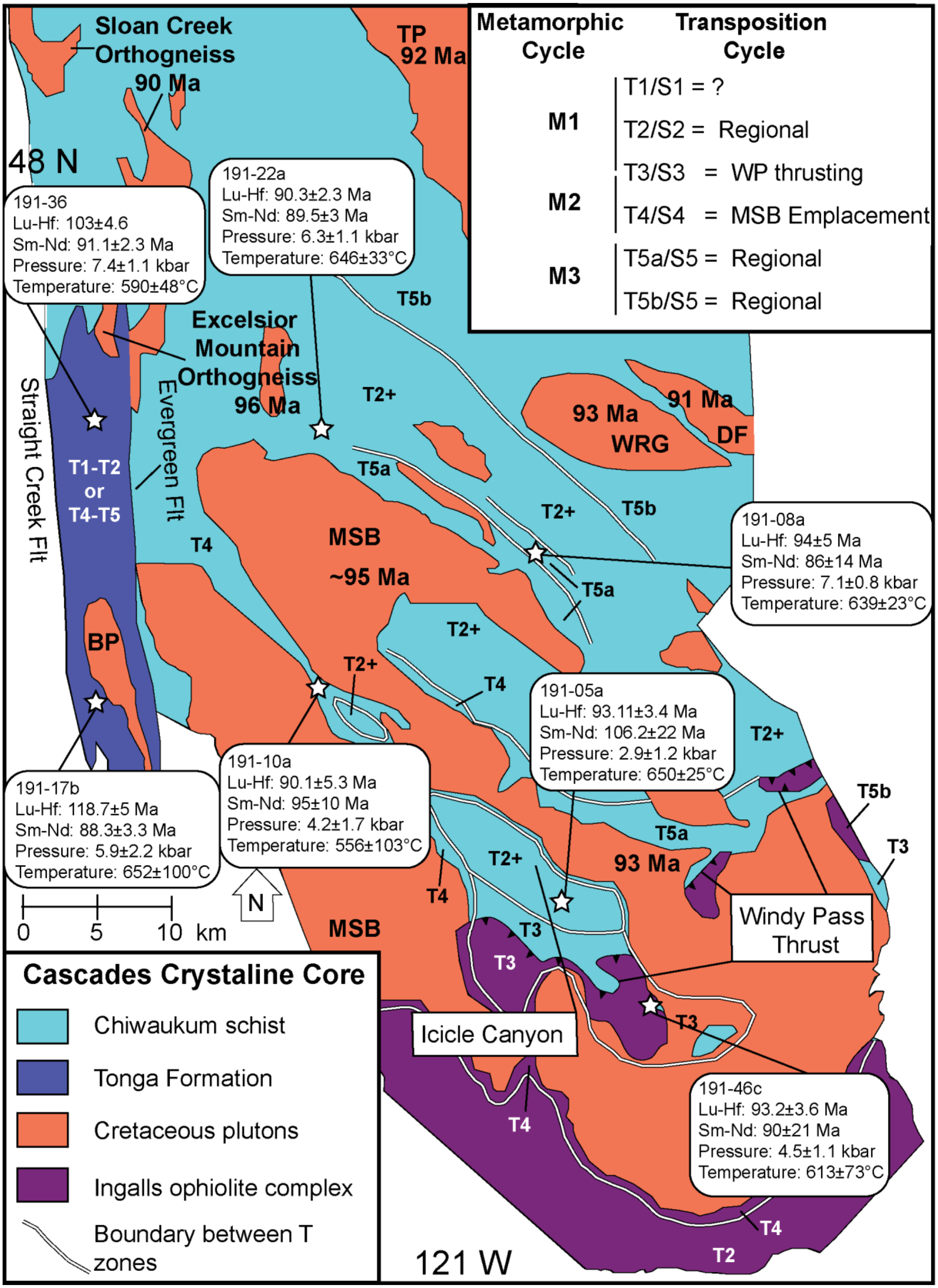
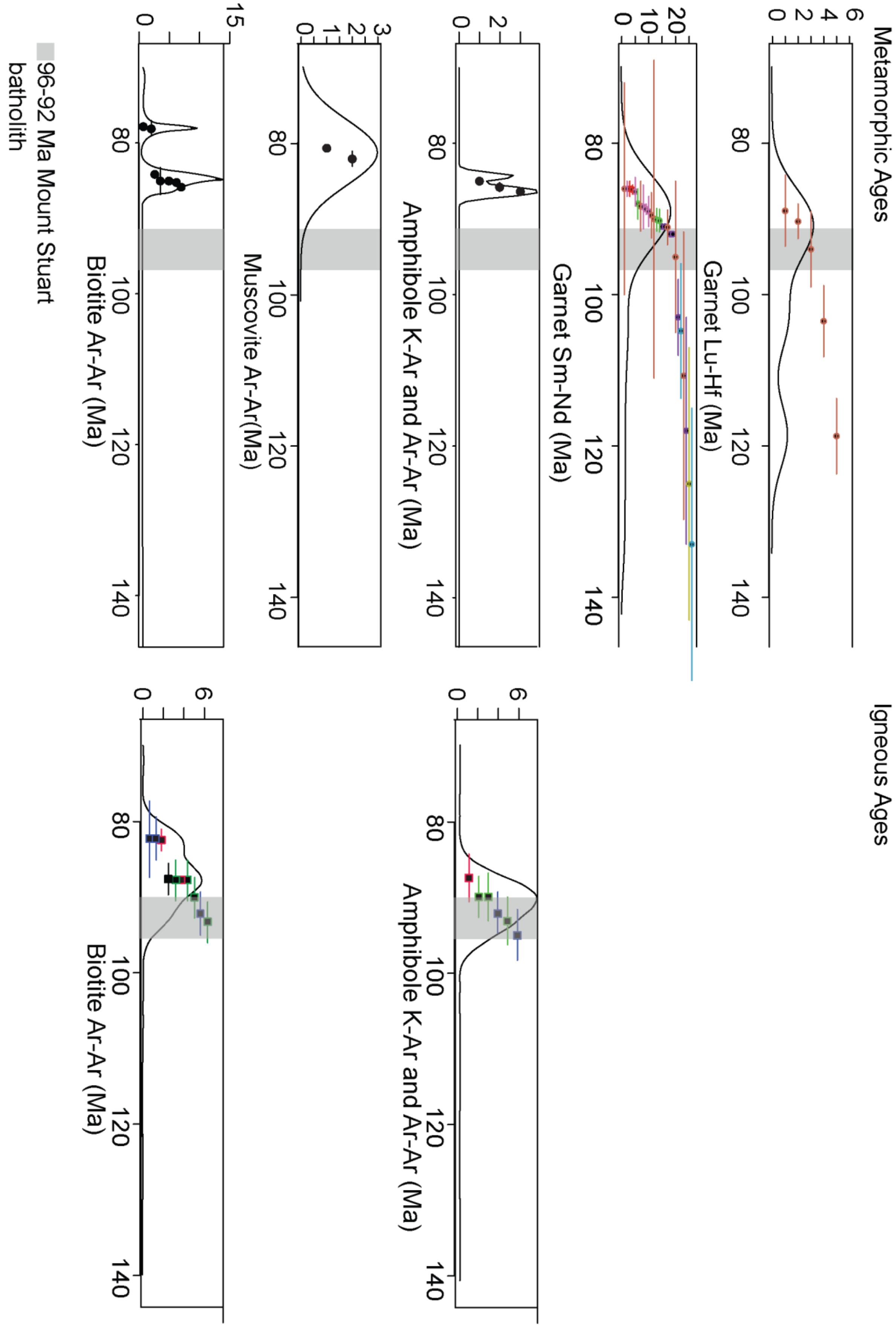

Sloan Creek Orthogneiss 90 Ma
TP 92 Ma
Metamorphic Cycle
Transposition Cycle
M1
T1/S1 = ?
T2/S2 = Regional
T3/S3 = WP thrusting
M2
T4/S4 = MSB Emplacement
M3
T5a/S5 = Regional
T5b/S5 = Regional
48 N
191-36
Lu-Hf: 103±4.6
Sm-Nd: 91.1±2.3 Ma
Pressure: 7.4±1.1 kbar
Temperature: 590±48°C
191-22a
Lu-Hf: 90.3±2.3 Ma
Sm-Nd: 89.5±3 Ma
Pressure: 6.3±1.1 kbar
Temperature: 646±33°C
T5b
Excelsior Mountain Orthogneiss 96 Ma
Straight Creek Flt
Evergreen Flt
T2+
93 Ma WRG
91 Ma
DF
T1-T2 or T4-T5
T5a
T2+
T5b
T4
MSB ~95 Ma
191-08a
Lu-Hf: 94±5 Ma
Sm-Nd: 86±14 Ma
Pressure: 7.1±0.8 kbar
Temperature: 639±23°C
T5a
T2+
BP
T2+
T4
191-05a
Lu-Hf: 93.11±3.4 Ma
Sm-Nd: 106.2±22 Ma
Pressure: 2.9±1.2 kbar
Temperature: 650±25°C
T2+
191-17b
Lu-Hf: 118.7±5 Ma
Sm-Nd: 88.3±3.3 Ma
Pressure: 5.9±2.2 kbar
Temperature: 652±100°C
191-10a
Lu-Hf: 90.1±5.3 Ma
Sm-Nd: 95±10 Ma
Pressure: 4.2±1.7 kbar
Temperature: 556±103°C
T5b
T5a
T3
T2+
93 Ma
T4
N
0 5 10 km
MSB
T3
Windy Pass Thrust
T3
Cascades Crystaline Core
Chiwaukum schist
Tonga Formation
Cretaceous plutons
Ingalls ophiolite complex
Boundary between T zones
Icicle Canyon
T3
191-46c
Lu-Hf: 93.2±3.6 Ma
Sm-Nd: 90±21 Ma
Pressure: 4.5±1.1 kbar
Temperature: 613±73°C
T4
T4
T2
121 W

Figure 4

Generalized geologic map of the southern Cascades Crystalline Core displaying field locations of select samples collected as part of this study as white stars and locations/boundaries (white lines with black borders) of proposed transposition cycles after Paterson et al. (1994). Numbers refer to the youngest transposition cycle observed in a domain. Age uncertainty is reported at 2-sigma and pressure and temperature calculated by the AVPT method with uncertainty is reported at 2-sigma (Table 6). MSB- Mount Stuart Batholith; BP- Beckler Peak pluton; WRG – Wetatchee Ridge Orthogneiss; DF – Dirty Face pluton; TP Ten Peak pluton.



Metamorphic Ages
Igneous Ages
Garnet Lu-Hf (Ma)
Garnet Sm-Nd (Ma)
Amphibole K-Ar and Ar-Ar (Ma)
Muscovite Ar-Ar(Ma)
Biotite Ar-Ar (Ma)
96-92 Ma Mount Stuart batholith

Figure 5

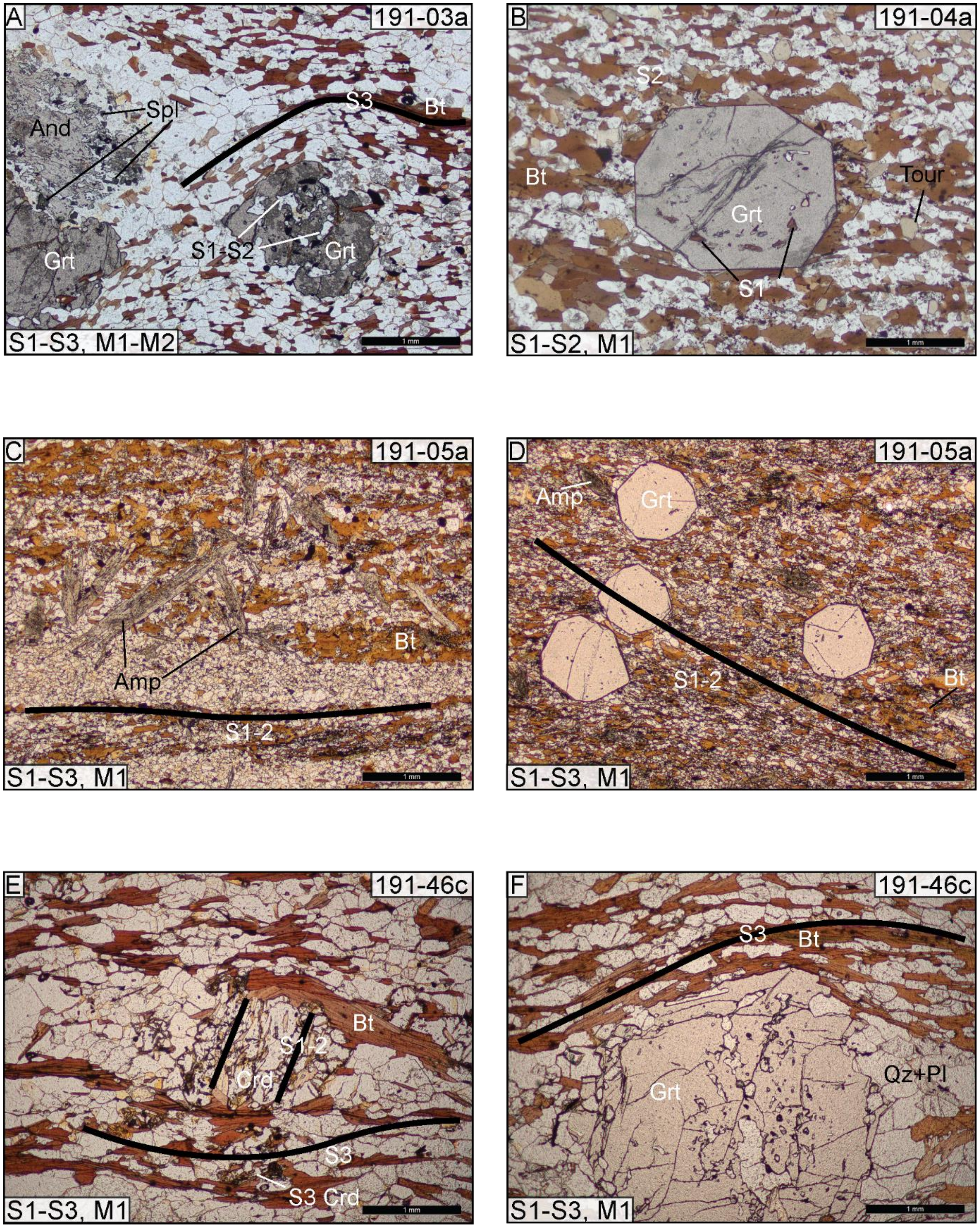
Probability density plots showing existing published geochronologic data and data collected as part of this study. Ages are grouped by mineral and the geochronologic system used to date them. Gray box indicates the approximate intrusive period of regional plutons. Existing geochronology compiled from Engels and Crowder (1971), Yeats and Engels (1971), Tabor et al. (1987), Magloughlin and Edwards (1992), Tabor et al. (1993), Magloughlin (1993), Chase (1998), Magloughlin and Edwards (1999), Evans and Davidson (1999), Stowell and Tinkham (2003), Stowell et al. (2011), Stowell unpublished, Holler (2013).

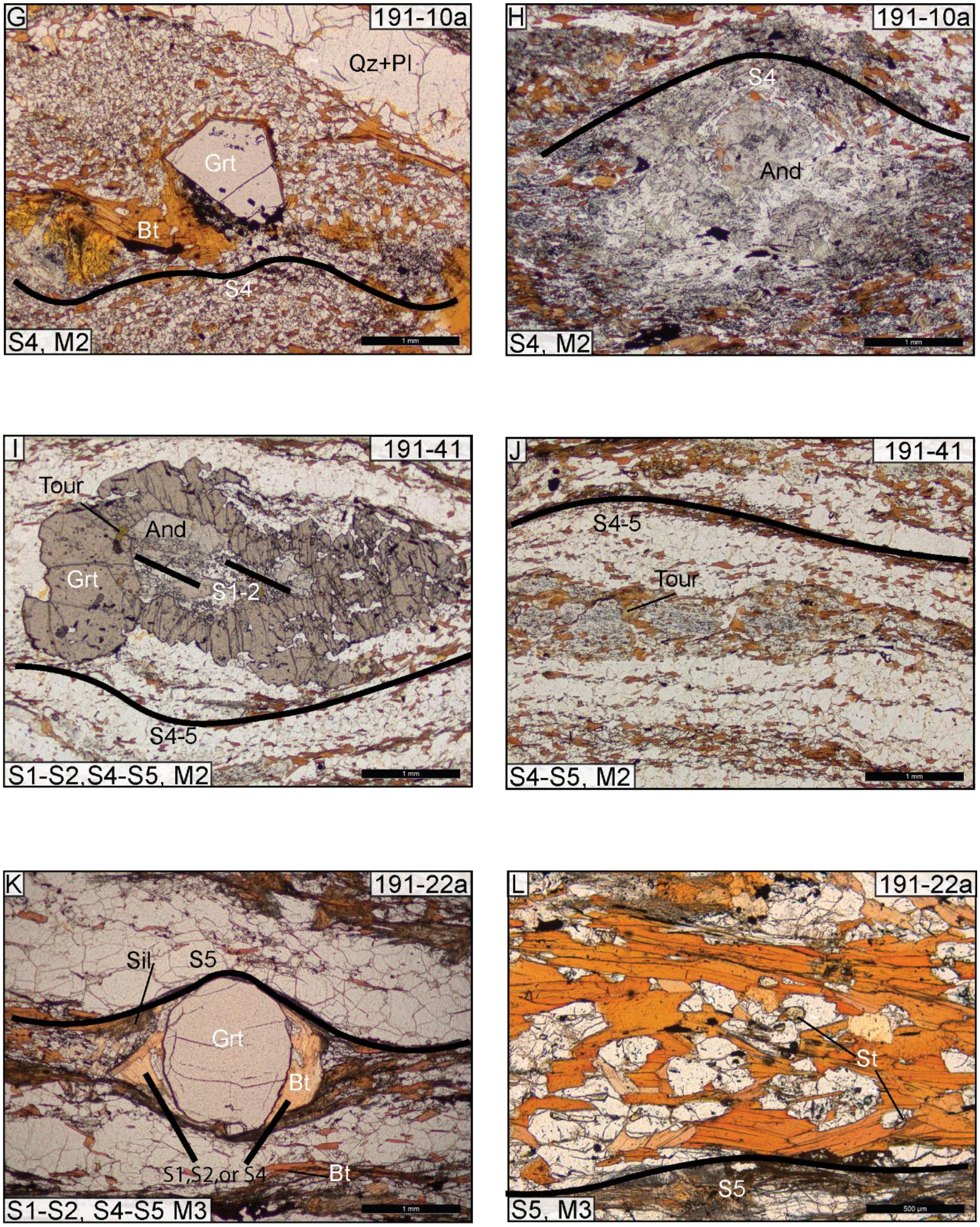

A
191-03a
S3
S1-S3, M1-M2
B
191-04a
S2
S1-S2, M1
C
191-05a
S2
F3 folds
S1-S2, M1
D
191-46c
S3, M1
E
191-46c
S3, M1
F
191-10a
S4, M2

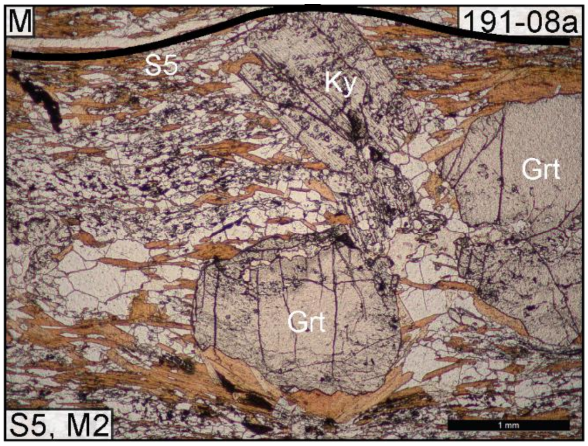

G
191-10a
S4
S4, M2
H
191-22a
GSA
S5
S5, M3
I
191-22a
GSA
HOTO SCALE/FOCUS GUIDE
S5
S5, M3
J
191-08a
S5
S5, M3

Figure 6

Outcrop photographs of units within the Chiwaukum schist. A) Large inclusion of M1 Chiwaukum Schist (sample 191-03a) within the Mount Stuart batholith reoriented by the Windy pass thrust near the Mount Stuart trailhead in Icicle Canyon. B) Sample 191-04a field photo collected just upstream of the bridge crossing Icicle Creek near the Chatter Creek Ranger Station. C) Field photo of sample 191-05a collected just downstream of the Rock Island Campground in Icicle Canyon. D), E) Field location of sample 191-46c adjacent to Lake Caroline meters below the T3 Windy pass thrust. F), G) Outcrop photographs of sample 191-10a and B collected near Tunnel creek from the contact aureole between the western and eastern lobes of Mount Stuart Batholith. F) shows T4/M2 cm scale andalusite and G) shows typical mm scale garnets dated as part of this study. H) and I) field photographs of sample 191-22a near Heather lake and sample 99NC67of Stowell and Tinkham (2003). H) shows typical moss-covered outcrop and sample location while I) shows typical ~3-5 mm scale garnets abundant throughout the rocks in the area. J) Sample location of sample 191-8a preserving T5/M3 kyanite and staurolite along US Highway 2. Scales for photos are either a mechanical pencil, a ~50cm long rock hammer, ~15 cm long chisel, ~6 ft tall field assistant or a scale.


A
191-03a
Spl
And
S3
Bt
Grt
S1-S2
Grt
S1-S3, M1-M2
B
191-04a
S2
Bt
Tour
Grt
S1
S1-S2, M1
C
191-05a
Bt
Amp
S1-2
S1-S3, M1
D
191-05a
Amp
Grt
S1-2
Bt
S1-S3, M1
E
191-46c
Bt
S1-2
Crd
S3
S3 Crd
S1-S3, M1
F
191-46c
S3
Bt
Qz+Pl
Grt
S1-S3, M1


G
191-10a
Qz+Pl
Grt
Bt
S4
S4, M2
1 mm
H
191-10a
S4
And
S4, M2
1 mm
I
191-41
Tour
And
Grt
S1-2
S4-5
S1-S2,S4-S5, M2
1 mm
J
191-41
S4-5
Tour
S4-S5, M2
1 mm
K
191-22a
Sil
S5
Grt
Bt
S1,S2 or S4
Bt
S1-S2, S4-S5 M3
1 mm
L
191-22a
St
S5
S5, M3
500 µm


M
191-08a
S5
Ky
Grt
Grt
S5, M2
1 mm

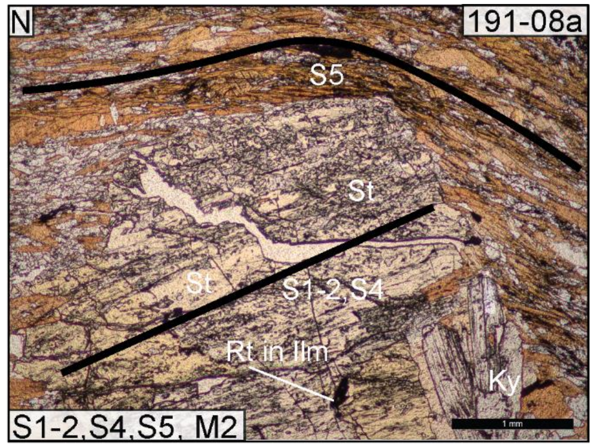
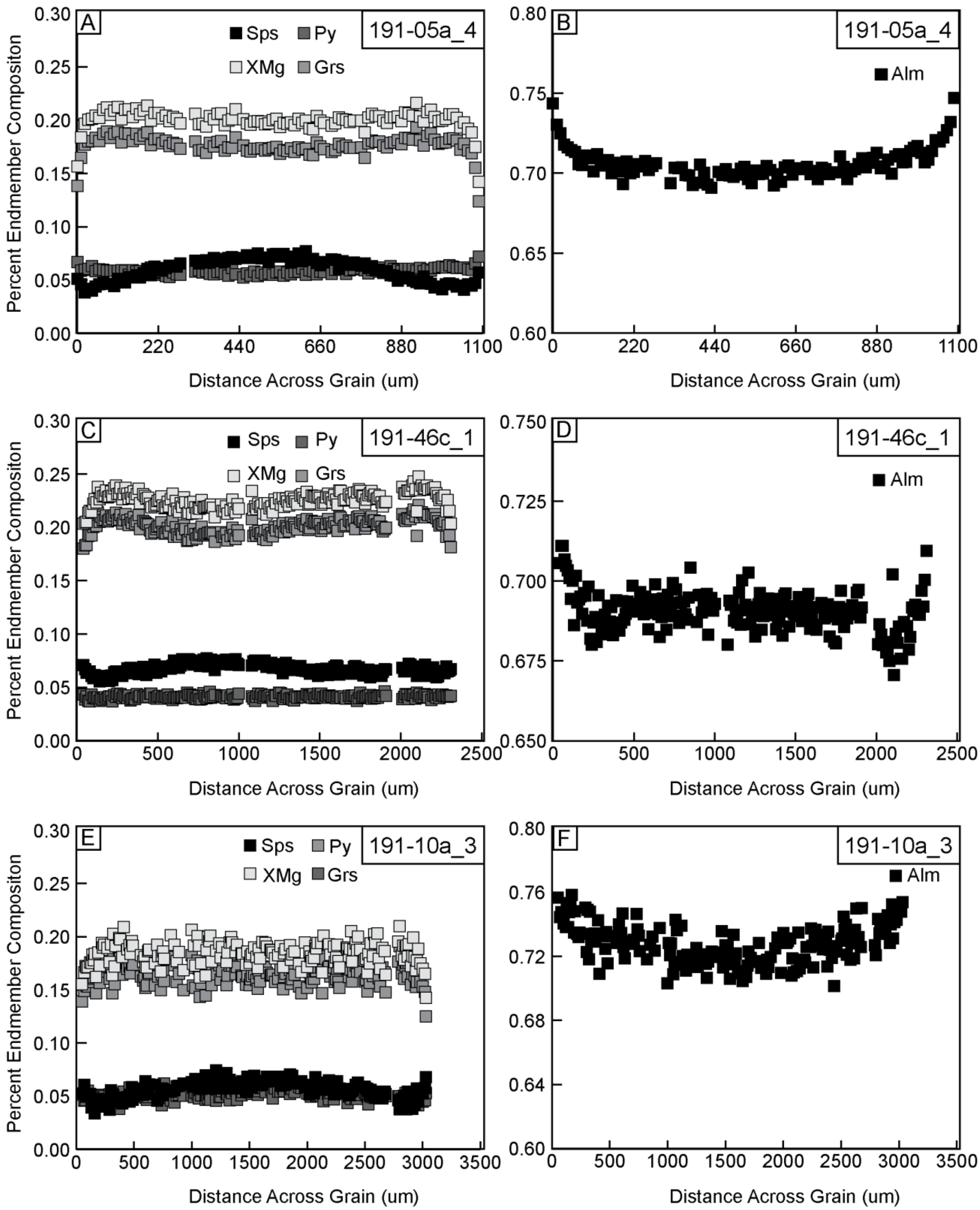

N
191-08a
S5
St
St
S1-2, S4
Rt in Ilm
Ky
S1-2,S4,S5, M2
1 mm

Figure 7

Photomicrographs of mineral assemblages from the Chiwaukum schist and Tonga formation. Sample locations are in Table 1, mineral assemblages in Table 2. M and T labels are inferred from mapping and discussion in Paterson (1994). A) Sample 191-03a And-Chl-Grt-Crd-Bt schist from the Mount Stuart trailhead. B) Sample 191-04a Chl-Grt-Bt schist. C,D) Sample 191-05a Grt-Amp-Bt schist. E,F) Sample 191-46c Grt-Crd-Bt schist. G,H) Sample 191-10a Chl-And-Grt-Bt schist. I,J) Sample 191-41 Grt-And-Bt schist. K, L) Sample 191-22a St-Grt-Sil-Bt schist. M,N) Sample 191-08a Ms-St-Ky-Grt-Bt schist. Black and white scale bars in the bottom right corners of each photo are 1mm or 0.5 mm in length.



A
191-05a_4
Sps
Py
XMg
Grs
Percent Endmember Compositon
Distance Across Grain (um)
B
191-05a_4
Alm
Distance Across Grain (um)
C
191-46c_1
Sps
Py
XMg
Grs
Percent Endmember Compositon
Distance Across Grain (um)
D
191-46c_1
Alm
Distance Across Grain (um)
E
191-10a_3
Sps
Py
XMg
Grs
Percent Endmember Compositon
Distance Across Grain (um)
F
191-10a_3
Alm
Distance Across Grain (um)

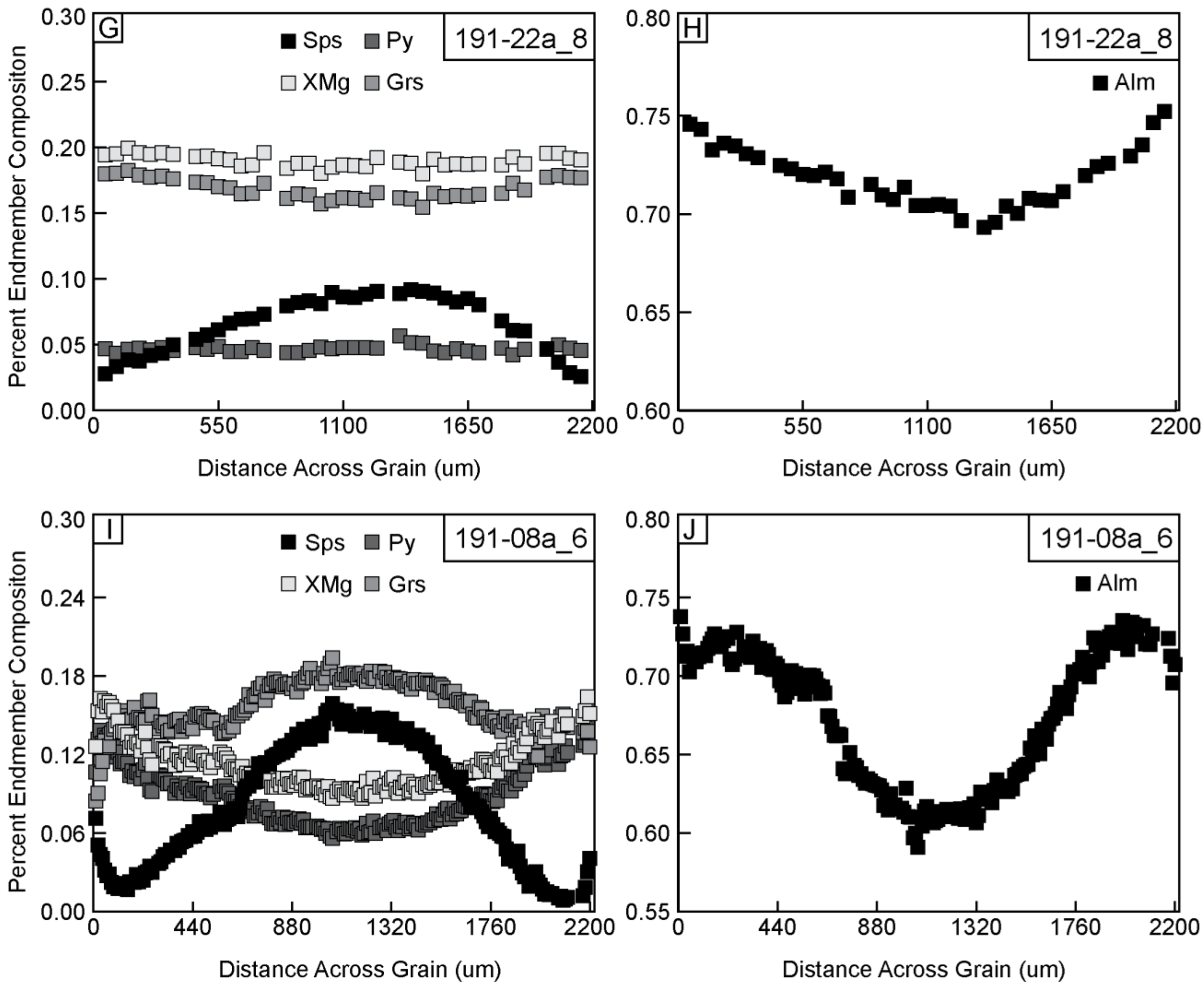

G
Sps
Py
XMg
Grs
191-22a_8
Percent Endmember Compositon
Distance Across Grain (um)
H
191-22a_8
Alm
Distance Across Grain (um)
I
Sps
Py
XMg
Grs
191-08a_6
Percent Endmember Compositon
Distance Across Grain (um)
J
191-08a_6
Alm
Distance Across Grain (um)

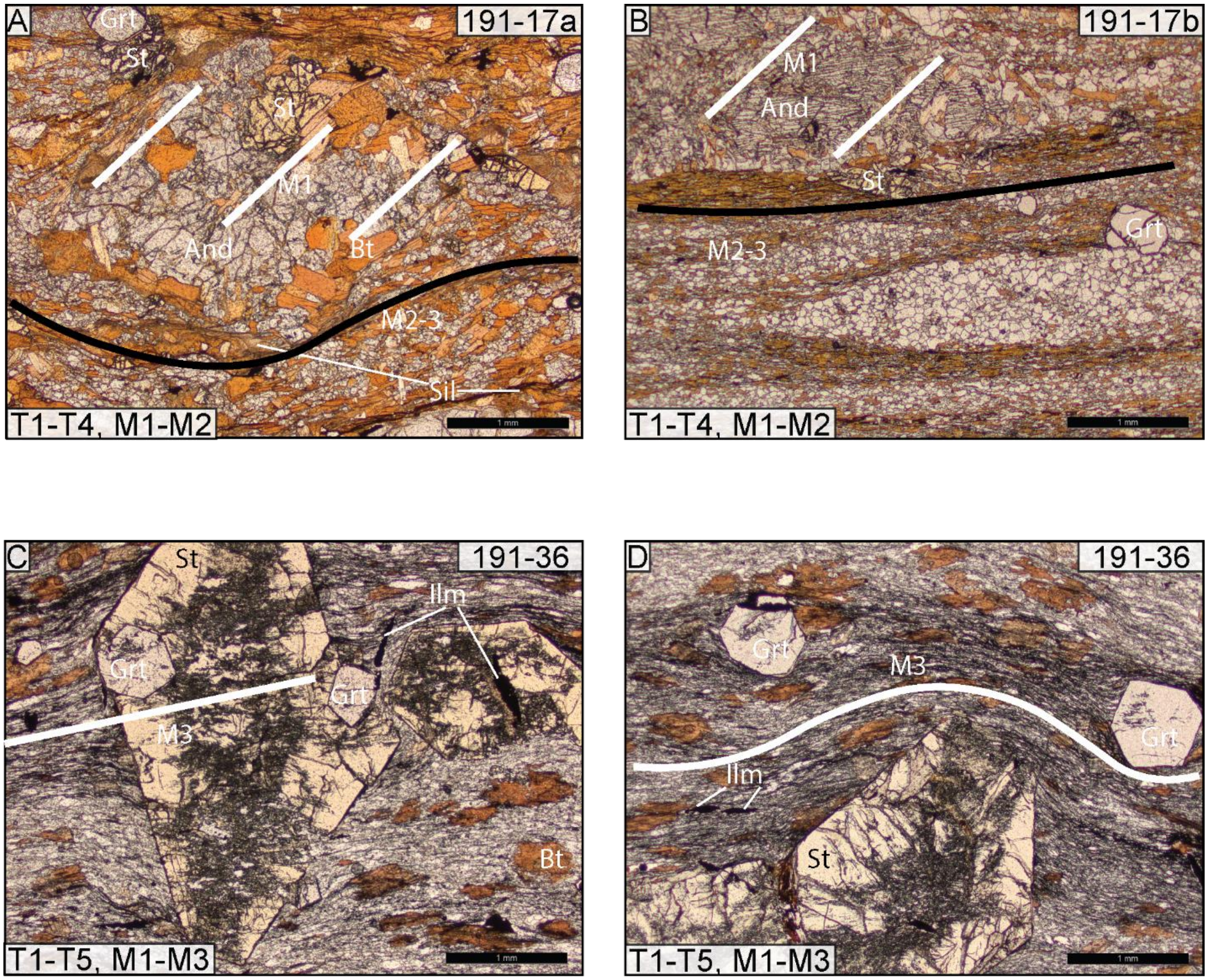
Figure 8

Garnet end-member compositional profiles in samples of the Chiwaukum schist. Data summarized in Table 3. A) Grossular, Pyrope, Spessartine, and XMg zoning profile for sample 191-05a. B) Almandine zoning profile for sample 191-05a. C) Grossular, Pyrope, Spessartine, and XMg zoning profile for sample 191-46c. D) Almandine zoning profile for sample 191-46c. E) Grossular, Pyrope, Spessartine, and XMg zoning profile for sample 191-10a. F) Almandine zoning profile for sample 191-10a. G) Grossular, Pyrope, Spessartine, and XMg zoning profile for sample 191-22a. H) Almandine zoning profile for sample 191-22a. I) Grossular, Pyrope, Spessartine, and XMg zoning profile for sample 191-08a. J) Almandine zoning profile for sample 191-08a.


A
191-17a
191-17b
Beckler peak offshoot
191-17a
191-17b
T1-T4, M1-M2
B
191-17a
T1-T4, M1-M2
C
191-36
T1-T5, M1-M3
D
191-36
T1-T5, M1-M3

Figure 9

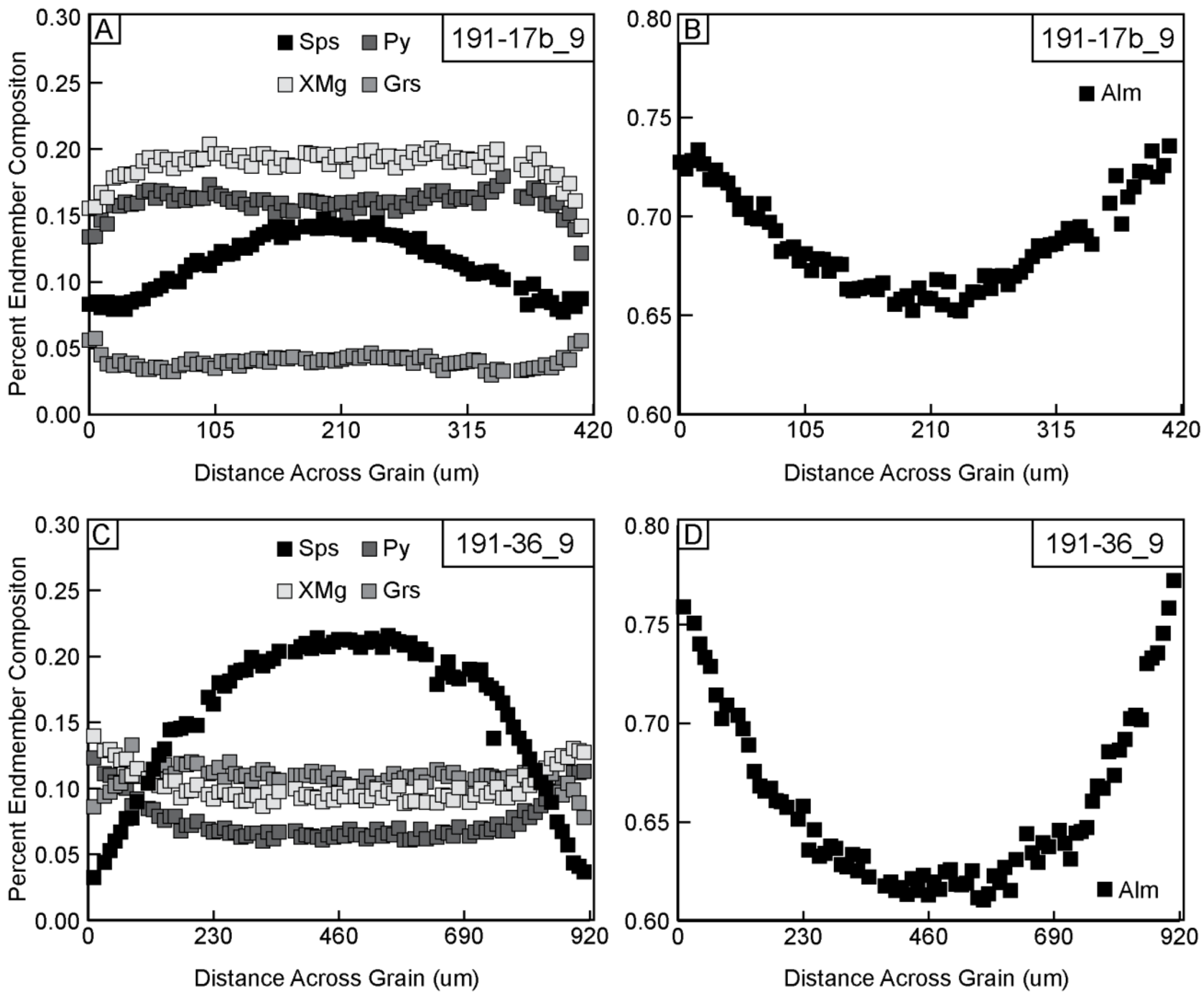
Outcrop photographs of units within the Tonga formation. A) Contact aureole of an offshoot of the Beckler Peak pluton in the Tonga Formation. Sample 191-17a (roughly three meters from the pluton) contains Sil+St after And. Sample 191-17b (roughly ten meters from the pluton) contains Bt-St after And. B) Field photograph of 191-17a C) 191-36 hand sample photograph showing large cm-scale foliation parallel staurolite. D) Outcrop photograph for sample 191-36 in the Tonga formation. Note steep dip of the foliation of this outcrop. Scales for photos are either a, a ~50cm long rock hammer, ~6 ft tall Brazilian field assistant or a scale.



A
191-17a
Grt
St
St
M1
And
Bt
M2-3
Sil
T1-T4, M1-M2
B
191-17b
M1
And
St
Grt
M2-3
T1-T4, M1-M2
C
191-36
St
Ilm
Grt
Grt
M3
Bt
T1-T5, M1-M3
D
191-36
Grt
M3
Grt
Ilm
St
T1-T5, M1-M3

Figure 10

Photomicrographs of mineral assemblages from the Tonga formation. A) Sample 191-17a St-And-Grt-Sil-Bt schist from the contact aureole of the Beckler Peak pluton. B) Sample 191-17b St-And-Grt-Bt schist from the contact aureole of the Beckler Peak pluton. C, D) Sample 191-36 St-Grt-Bt schist from the northern Tonga formation. Black and white scale bars in the bottom right corners of each photo are 1mm or 0.5 mm in length.



A
191-17b_9
Sps
Py
XMg
Grs
Percent Endmember Compositon
Distance Across Grain (um)
B
191-17b_9
Alm
Distance Across Grain (um)
C
191-36_9
Sps
Py
XMg
Grs
Percent Endmember Compositon
Distance Across Grain (um)
D
191-36_9
Alm
Distance Across Grain (um)

Figure 11

Garnet end-member compositional profiles in samples of the Tonga formation. Data summarized in Table 3. A) Grossular, Pyrope, Spessartine, and XMg zoning profile for sample 191-17b. B) Almandine zoning profile for sample 191-17b. C) Grossular, Pyrope, Spessartine, and XMg zoning profile for sample 191-36. D) Almandine zoning profile for sample 191-36.

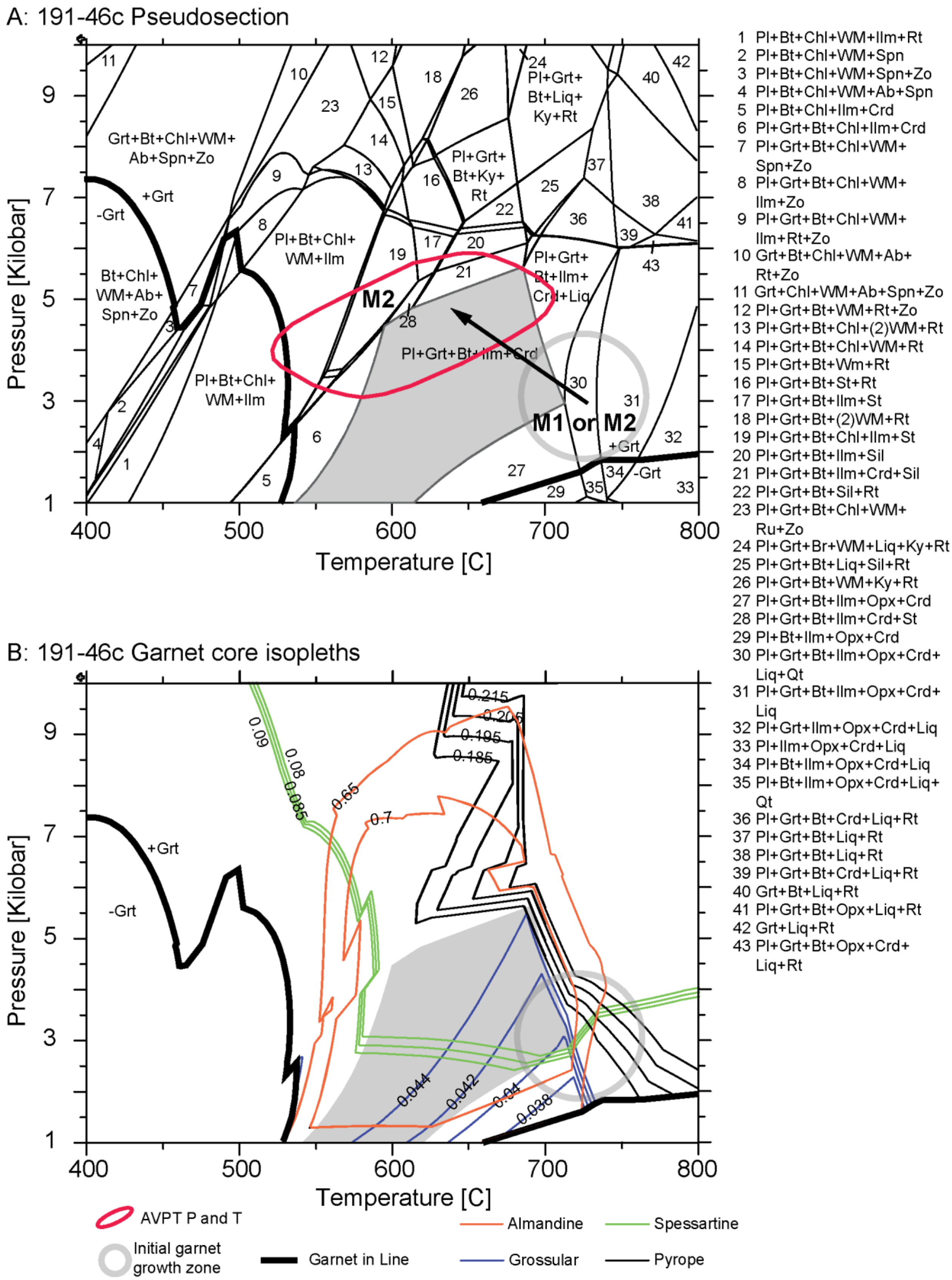
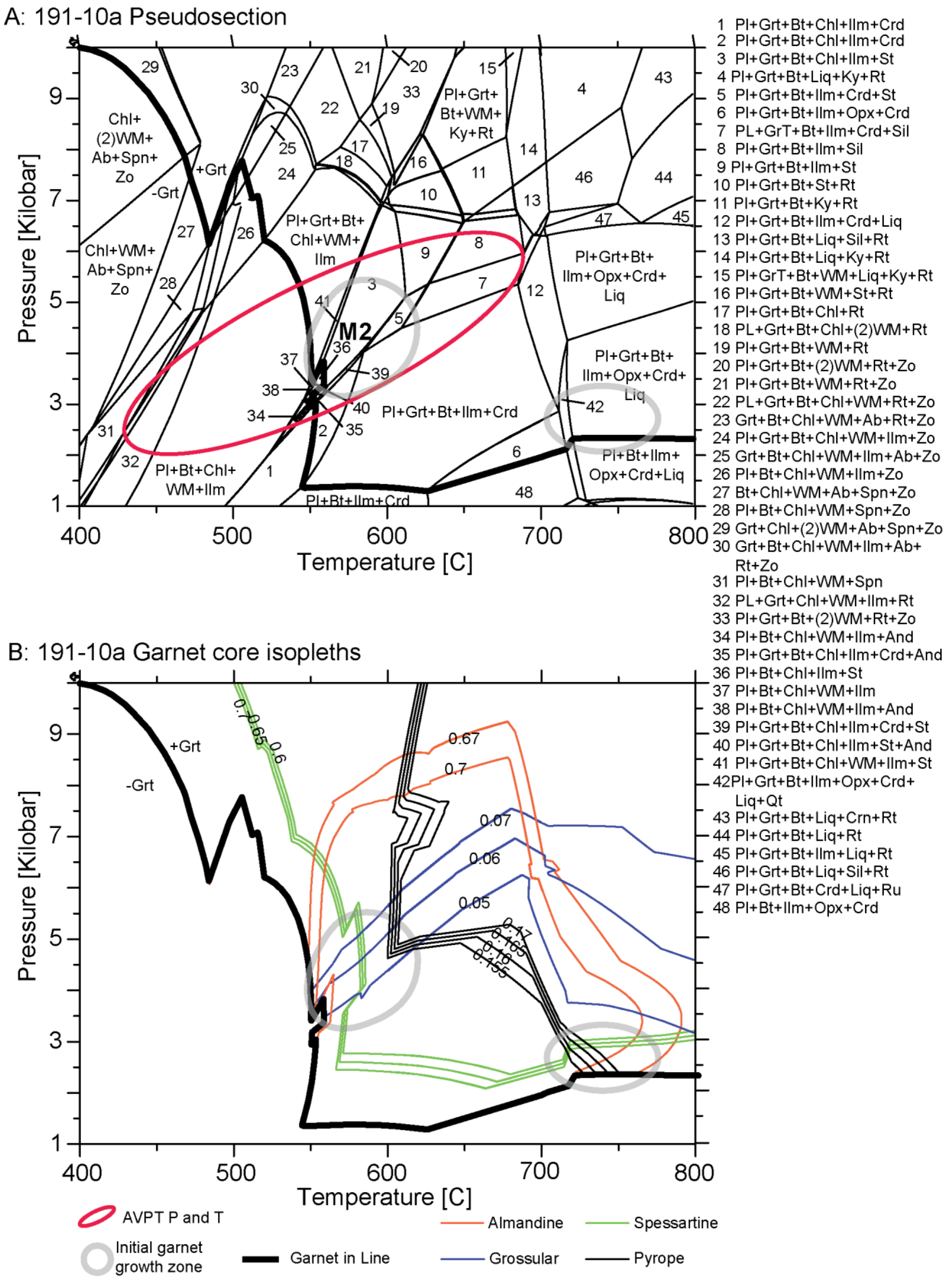

A: 191-46c Pseudosection
Pressure [Kilobar]
Temperature [C]
Grt+Bt+Chl+WM+Ab+Spn+Zo
+Grt
-Grt
Bt+Chl+WM+Ab+Spn+Zo
Pl+Bt+Chl+WM+Ilm
Pl+Bt+Chl+WM+Ilm
Pl+Grt+Bt+Ky+Rt
Pl+Grt+Bt+Liq+Ky+Rt
Pl+Grt+Bt+Ilm+Crd+Liq
Pl+Grt+Bt+Ilm+Crd
M2
M1 or M2
+Grt
-Grt
1 Pl+Bt+Chl+WM+Ilm+Rt
2 Pl+Bt+Chl+WM+Spn
3 Pl+Bt+Chl+WM+Spn+Zo
4 Pl+Bt+Chl+WM+Ab+Spn
5 Pl+Bt+Chl+Ilm+Crd
6 Pl+Grt+Bt+Chl+Ilm+Crd
7 Pl+Grt+Bt+Chl+WM+Spn+Zo
8 Pl+Grt+Bt+Chl+WM+Ilm+Zo
9 Pl+Grt+Bt+Chl+WM+Ilm+Rt+Zo
10 Grt+Bt+Chl+WM+Ab+Rt+Zo
11 Grt+Chl+WM+Ab+Spn+Zo
12 Pl+Grt+Bt+WM+Rt+Zo
13 Pl+Grt+Bt+Chl+(2)WM+Rt
14 Pl+Grt+Bt+Chl+WM+Rt
15 Pl+Grt+Bt+Wm+Rt
16 Pl+Grt+Bt+St+Rt
17 Pl+Grt+Bt+Ilm+St
18 Pl+Grt+Bt+(2)WM+Rt
19 Pl+Grt+Bt+Chl+Ilm+St
20 Pl+Grt+Bt+Ilm+Sil
21 Pl+Grt+Bt+Ilm+Crd+Sil
22 Pl+Grt+Bt+Sil+Rt
23 Pl+Grt+Bt+Chl+WM+Ru+Zo
24 Pl+Grt+Br+WM+Liq+Ky+Rt
25 Pl+Grt+Bt+Liq+Sil+Rt
26 Pl+Grt+Bt+WM+Ky+Rt
27 Pl+Grt+Bt+Ilm+Opx+Crd
28 Pl+Grt+Bt+Ilm+Crd+St
29 Pl+Bt+Ilm+Opx+Crd
30 Pl+Grt+Bt+Ilm+Opx+Crd+Liq+Qt
31 Pl+Grt+Bt+Ilm+Opx+Crd+Liq
32 Pl+Grt+Ilm+Opx+Crd+Liq
33 Pl+Ilm+Opx+Crd+Liq
34 Pl+Bt+Ilm+Opx+Crd+Liq
35 Pl+Bt+Ilm+Opx+Crd+Liq+Qt
36 Pl+Grt+Bt+Crd+Liq+Rt
37 Pl+Grt+Bt+Liq+Rt
38 Pl+Grt+Bt+Liq+Rt
39 Pl+Grt+Bt+Crd+Liq+Rt
40 Grt+Bt+Liq+Rt
41 Pl+Grt+Bt+Opx+Liq+Rt
42 Grt+Liq+Rt
43 Pl+Grt+Bt+Opx+Crd+Liq+Rt
B: 191-46c Garnet core isopleths
Pressure [Kilobar]
Temperature [C]
+Grt
-Grt
0.215
0.205
0.195
0.185
0.09
0.08
0.085
0.65
0.7
0.044
0.042
0.04
0.038
AVPT P and T
Initial garnet growth zone
Garnet in Line
Almandine
Grossular
Spessartine
Pyrope

Figure 12

A) Pressure-temperature pseudosection for sample 191-46c depicting mineral stabilities as a function of pressure and temperature. Stability field for the observed peak mineral assemblage is shaded in gray, interpreted zone of initiation of garnet growth outlined in gray, garnet stability field to the right of the bold black line, and results of average pressure and temperature calculations (Table 6) in red. Average pressure and temperature error plotted as 1 sigma. Interpreted zone of garnet growth initiation outlined in gray. B) Garnet almandine, grossular, pyrope, and spessartine end-member core isopleths. Interpreted zone of garnet growth initiation outlined in gray. Arrow indicates the prograde metamorphic path.



A: 191-10a Pseudosection
Pressure [Kilobar]
Temperature [C]
Chl+ (2)WM+ Ab+Spn+ Zo
Chl+WM+ Ab+Spn+ Zo
+Grt
-Grt
Pl+Grt+Bt+ Chl+WM+ Ilm
Pl+Grt+ Bt+WM+ Ky+Rt
Pl+Grt+Bt+ Ilm+Opx+Crd+ Liq
Pl+Grt+Bt+Ilm+Crd
Pl+Bt+Chl+ WM+Ilm
Pl+Bt+Ilm+Crd
Pl+Bt+Ilm+ Opx+Crd+Liq
M2
B: 191-10a Garnet core isopleths
Pressure [Kilobar]
Temperature [C]
AVPT P and T
Initial garnet growth zone
Garnet in Line
Almandine
Grossular
Spessartine
Pyrope
1 Pl+Grt+Bt+Chl+Ilm+Crd
2 Pl+Grt+Bt+Chl+Ilm+Crd
3 Pl+Grt+Bt+Chl+Ilm+St
4 Pl+Grt+Bt+Liq+Ky+Rt
5 Pl+Grt+Bt+Ilm+Crd+St
6 Pl+Grt+Bt+Ilm+Opx+Crd
7 PL+GrT+Bt+Ilm+Crd+Sil
8 Pl+Grt+Bt+Ilm+Sil
9 Pl+Grt+Bt+Ilm+St
10 Pl+Grt+Bt+St+Rt
11 Pl+Grt+Bt+Ky+Rt
12 Pl+Grt+Bt+Ilm+Crd+Liq
13 Pl+Grt+Bt+Liq+Sil+Rt
14 Pl+Grt+Bt+Liq+Ky+Rt
15 Pl+GrT+Bt+WM+Liq+Ky+Rt
16 Pl+Grt+Bt+WM+St+Rt
17 Pl+Grt+Bt+Chl+Rt
18 PL+Grt+Bt+Chl+(2)WM+Rt
19 Pl+Grt+Bt+WM+Rt
20 Pl+Grt+Bt+(2)WM+Rt+Zo
21 Pl+Grt+Bt+WM+Rt+Zo
22 PL+Grt+Bt+Chl+WM+Rt+Zo
23 Grt+Bt+Chl+WM+Ab+Rt+Zo
24 Pl+Grt+Bt+Chl+WM+Ilm+Zo
25 Grt+Bt+Chl+WM+Ilm+Ab+Zo
26 Pl+Bt+Chl+WM+Ilm+Zo
27 Bt+Chl+WM+Ab+Spn+Zo
28 Pl+Bt+Chl+WM+Spn+Zo
29 Grt+Chl+(2)WM+Ab+Spn+Zo
30 Grt+Bt+Chl+WM+Ilm+Ab+ Rt+Zo
31 Pl+Bt+Chl+WM+Spn
32 PL+Grt+Chl+WM+Ilm+Rt
33 Pl+Grt+Bt+(2)WM+Rt+Zo
34 Pl+Bt+Chl+WM+Ilm+And
35 Pl+Grt+Bt+Chl+Ilm+Crd+And
36 Pl+Bt+Chl+Ilm+St
37 Pl+Bt+Chl+WM+Ilm
38 Pl+Bt+Chl+WM+Ilm+And
39 Pl+Grt+Bt+Chl+Ilm+Crd+St
40 Pl+Grt+Bt+Chl+Ilm+St+And
41 Pl+Grt+Bt+Chl+WM+Ilm+St
42Pl+Grt+Bt+Ilm+Opx+Crd+ Liq+Qt
43 Pl+Grt+Bt+Liq+Crn+Rt
44 Pl+Grt+Bt+Liq+Rt
45 Pl+Grt+Bt+Ilm+Liq+Rt
46 Pl+Grt+Bt+Liq+Sil+Rt
47 Pl+Grt+Bt+Crd+Liq+Ru
48 Pl+Bt+Ilm+Opx+Crd

Figure 13

A) Pressure-temperature pseudosection for sample 191-10a depicting mineral stabilities as a function of pressure and temperature, stability field for interpreted peak minerology shaded in gray, garnet stability field to the right of the bold black line, interpreted zone of initiation of garnet growth outlined in gray, and results of average pressure and temperature calculations in red (Table 6). Average pressure and temperature error plotted as 1 sigma. Note two zones of partial isopleth convergence outlined in gray. B) Garnet almandine, grossular, pyrope, and spessartine end-member core isopleths. Note two zones of partial isopleth convergence outlined in gray. The zone to the left excludes pyrope and the zone to the right excludes grossular. Arrow indicates the prograde metamorphic path.

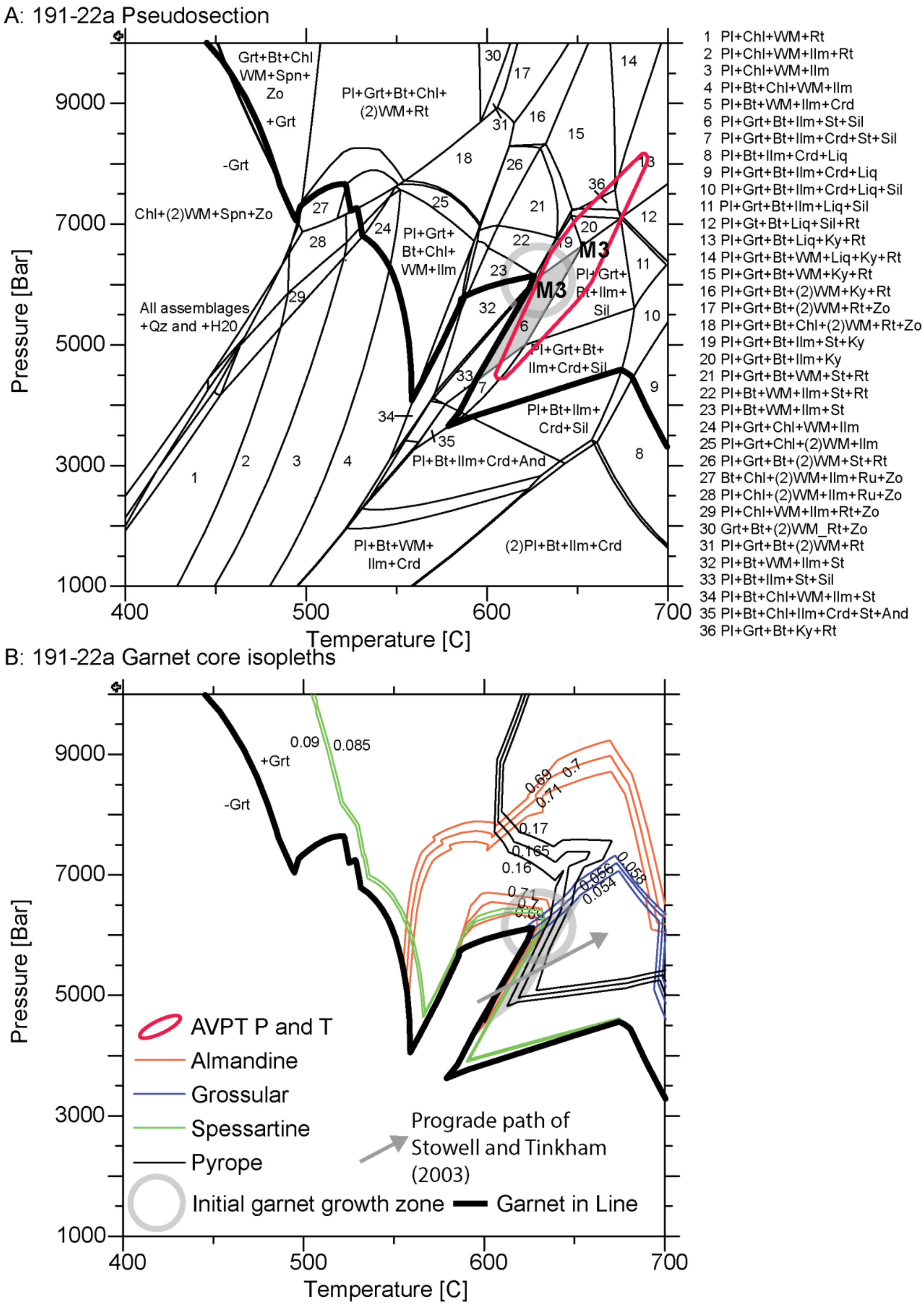
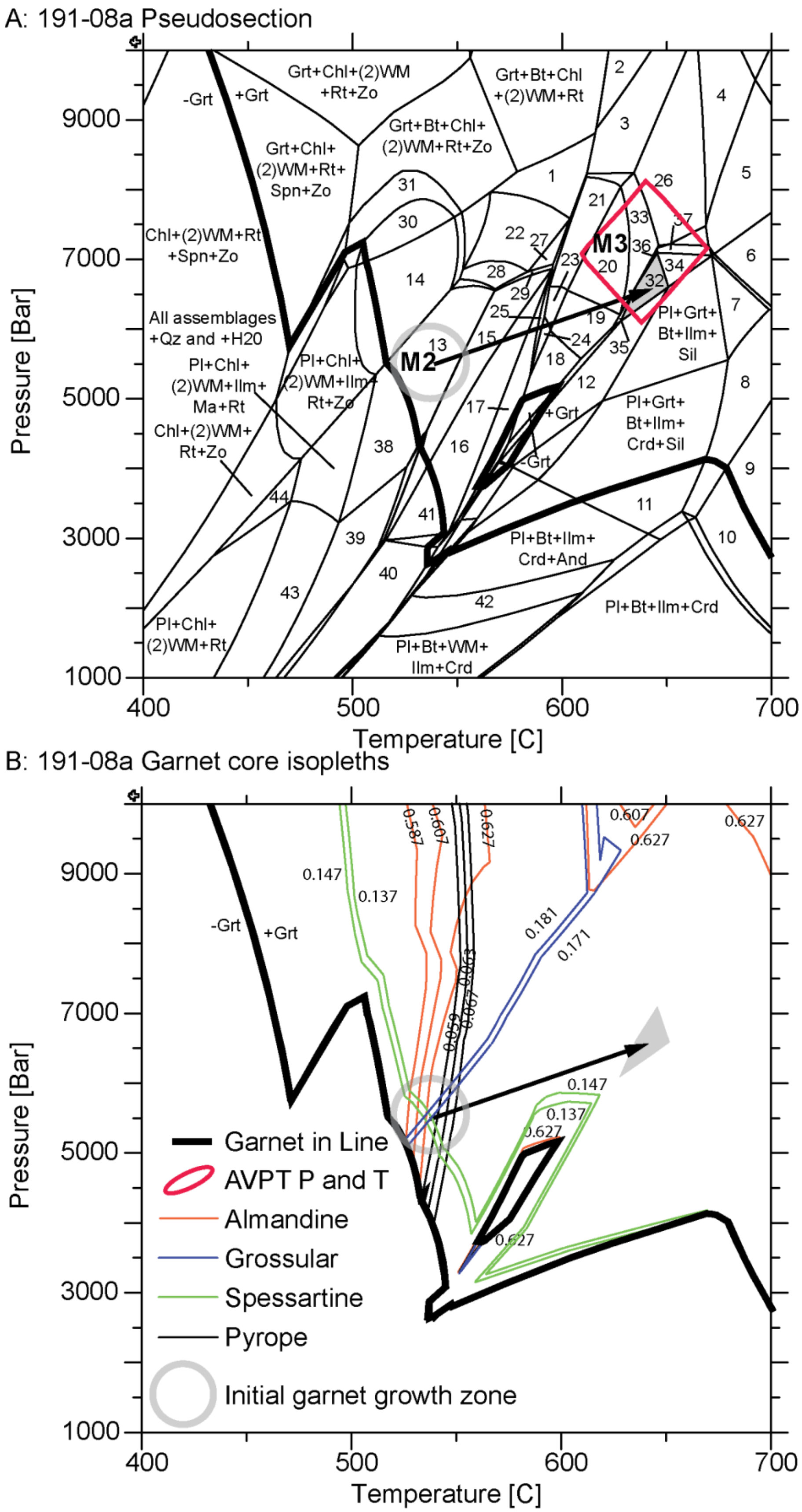

A: 191-22a Pseudosection
Grt+Bt+Chl WM+Spn+ Zo
+Grt
-Grt
Pl+Grt+Bt+Chl+ (2)WM+Rt
Chl+(2)WM+Spn+Zo
Pl+Grt+ Bt+Chl+ WM+Ilm
All assemblages +Qz and +H2O
M3
Pl+Grt+ Bt+Ilm+ Sil
Pl+Grt+Bt+ Ilm+Crd+Sil
Pl+Bt+Ilm+ Crd+Sil
Pl+Bt+Ilm+Crd+And
Pl+Bt+WM+ Ilm+Crd
(2)Pl+Bt+Ilm+Crd
Pressure [Bar]
Temperature [C]
1 Pl+Chl+WM+Rt
2 Pl+Chl+WM+Ilm+Rt
3 Pl+Chl+WM+Ilm
4 Pl+Bt+Chl+WM+Ilm
5 Pl+Bt+WM+Ilm+Crd
6 Pl+Grt+Bt+Ilm+St+Sil
7 Pl+Grt+Bt+Ilm+Crd+St+Sil
8 Pl+Bt+Ilm+Crd+Liq
9 Pl+Grt+Bt+Ilm+Crd+Liq
10 Pl+Grt+Bt+Ilm+Crd+Liq+Sil
11 Pl+Grt+Bt+Ilm+Liq+Sil
12 Pl+Gt+Bt+Liq+Sil+Rt
13 Pl+Grt+Bt+Liq+Ky+Rt
14 Pl+Grt+Bt+WM+Liq+Ky+Rt
15 Pl+Grt+Bt+WM+Ky+Rt
16 Pl+Grt+Bt+(2)WM+Ky+Rt
17 Pl+Grt+Bt+(2)WM+Rt+Zo
18 Pl+Grt+Bt+Chl+(2)WM+Rt+Zo
19 Pl+Grt+Bt+Ilm+St+Ky
20 Pl+Grt+Bt+Ilm+Ky
21 Pl+Grt+Bt+WM+St+Rt
22 Pl+Bt+WM+Ilm+St+Rt
23 Pl+Bt+WM+Ilm+St
24 Pl+Grt+Chl+WM+Ilm
25 Pl+Grt+Chl+(2)WM+Ilm
26 Pl+Grt+Bt+(2)WM+St+Rt
27 Bt+Chl+(2)WM+Ilm+Ru+Zo
28 Pl+Chl+(2)WM+Ilm+Ru+Zo
29 Pl+Chl+WM+Ilm+Rt+Zo
30 Grt+Bt+(2)WM_Rt+Zo
31 Pl+Grt+Bt+(2)WM+Rt
32 Pl+Bt+WM+Ilm+St
33 Pl+Bt+Ilm+St+Sil
34 Pl+Bt+Chl+WM+Ilm+St
35 Pl+Bt+Chl+Ilm+Crd+St+And
36 Pl+Grt+Bt+Ky+Rt
B: 191-22a Garnet core isopleths
AVPT P and T
Almandine
Grossular
Spessartine
Pyrope
Initial garnet growth zone
Garnet in Line
Prograde path of Stowell and Tinkham (2003)
Pressure [Bar]
Temperature [C]

Figure 14

A) Pressure-temperature pseudosection for sample 191-22a depicting mineral stabilities as a function of pressure and temperature. Stability field for the observed peak mineral assemblage is shaded in gray, garnet stability field to the right of the bold black line, interpreted zone of initiation of garnet growth outlined in gray, and results of average pressure and temperature calculations in red (Table 6). Average pressure and temperature error plotted as 1 sigma. Interpreted zone of garnet growth initiation outlined in gray. B) Garnet almandine, grossular, pyrope, and spessartine end-member core isopleths. Interpreted zone of garnet growth initiation outlined in gray. Arrow indicates the prograde metamorphic path of Stowell and Tinkham (2003).

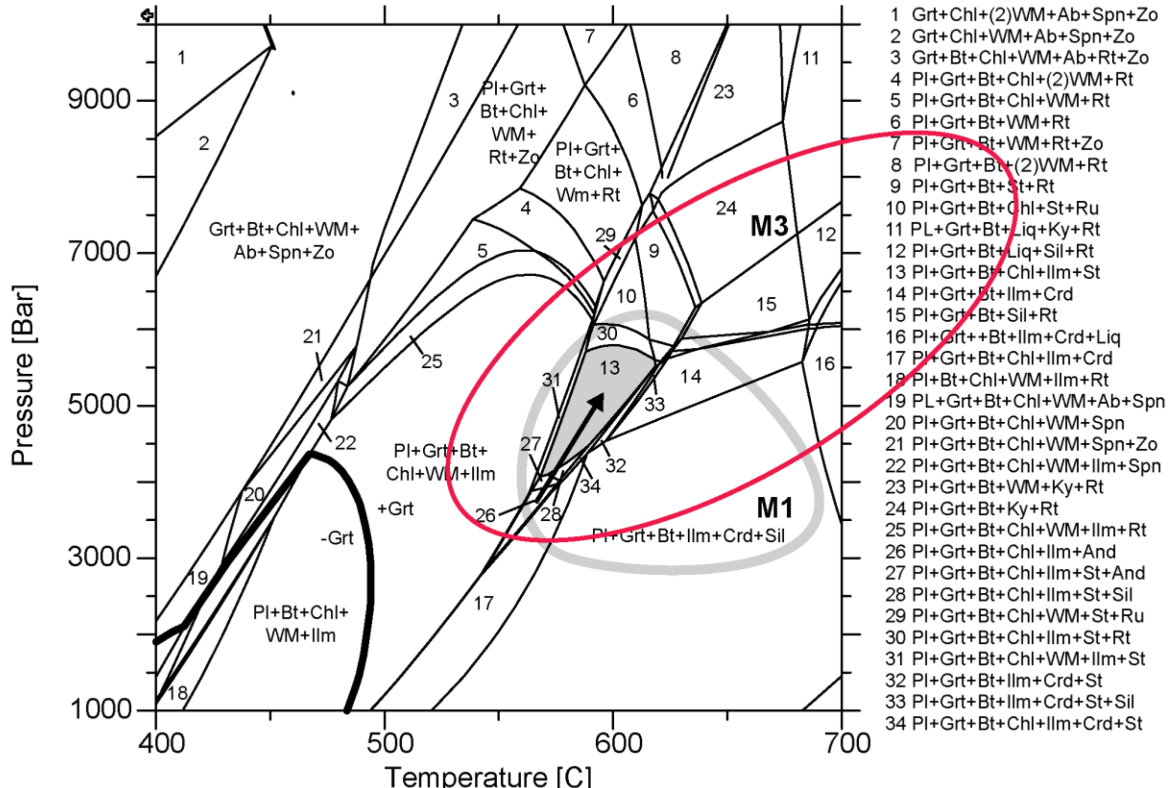


1 Pl+Grt+Bt+Chl+(2)WM+Rt
2 Grt+Bt+(2)WM+Ky+Rt
3 Pl+Grt+Bt+(2)WM+Ky+Rt
4 Pl+Grt+Bt+WM+Liq+Ky+Rt
5 Pl+Grt+Bt+Liq+Ky+Rt
6 Pl+Grt+Bt+Liq+Sil+Rt
7 Pl+Grt+Bt+Ilm+Liq+Sil
8 Pl+Grt+Bt+Ilm+Crd+Liq+Sil
9 Pl+Grt+Bt+Ilm+Crd+Liq
10 Pl+Bt+Ilm+Crd+Liq
11 Pl+Bt+Ilm+Crd+Sil
12 Pl+Grt+Bt+Ilm+St+Sil
13 Pl+Grt+(2)WM+Ilm+Zo+Mag
14 Pl+Grt+Chl+(2)WM+Ilm+Zo
15 Pl+Grt+Chl+(2)WM+Ilm+St
16 Pl+Grt+Chl+WM+Ilm+St
17 Pl+Grt+Bt+Chl+WM+Ilm+St
18 Pl+Grt+Bt+WM+Ilm+St
19 Pl+Grt+Bt+WM+Ilm+St+Rt
20 Pl+Grt+Bt+WM+St+Rt
21 Pl+Grt+Bt+(2)WM+St+Rt
22 Pl+Grt+Bt+Chl+(2)WM+Rt
23 Pl+Grt+Bt+WM+Ilm+St+Rt
24 Pl+Grt+Bt+(2)WM+Ilm+St
25 Pl+Grt+Bt-Chl+(2)WM+Ilm+St
26 Pl+Grt+Bt+WM+Ky+Rt
27 Pl+Grt+Bt+Chl+(2)WM+St+Rt
28 Pl+Grt+Bt+Chl+(2)WM+Ilm+Rt
29 Pl+Grt+Bt+Chl+(2)WM+Ilm+St+Rt
30 Pl+Grt+Bt+Chl+(2)WM+Ilm+Zo
31 Pl+Grt+Bt+Chl+(2)WM+Ilm+Rt+Zo
32 Pl+Grt-Bt+Ilm+St+Ky
33 Pl+Grt+Bt+WM+St+Ky+Rt
34 Pl+Grt-Bt-Ilm-Ky+Rt
35 Pl+Grt-Bt+WM+Ilm+St+Ky
36 Pl+Grt+Bt+Ilm+St+Ky+Rt
37 Pl+Grt-Bt-Ilm-Ky
38 Pl+Chl+(2)WM+Ilm+Mag
39 Pl+Chl+(2)WM+Ilm+Mag
40 Pl+Chl+WM+Ilm+And
41 Pl+Chl+WM+Ilm+St
42 Pl+Bt+WM+Ilm+Crd+And
43 Pl+Chl+(2)WM+Ilm+Rt
44 Pl+Chl+(2)WM+Mag+Rt

Figure 15

A) Pressure-temperature pseudosection for sample 191-08a depicting mineral stabilities as a function of pressure and temperature. Stability field for the observed peak mineral assemblage is shaded in gray, garnet stability field to the right of the bold black line, interpreted zone of initiation of garnet growth outlined in gray, and results of average pressure and temperature calculations in red (Table 6). Average pressure and temperature error plotted as 1 sigma. B) Garnet almandine, grossular, pyrope, and spessartine end-member core isopleths. Interpreted zone of garnet growth initiation outlined in gray. Arrow indicates the prograde metamorphic path.

A: 191-17b Pseudosection



B: 191-17b Garnet core isopleths

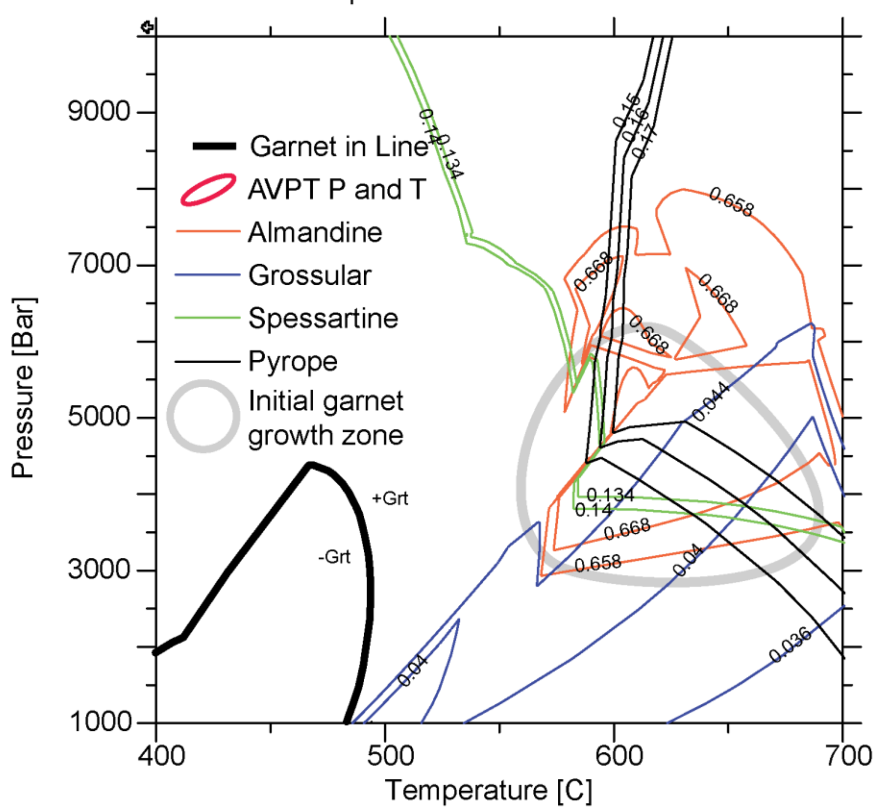
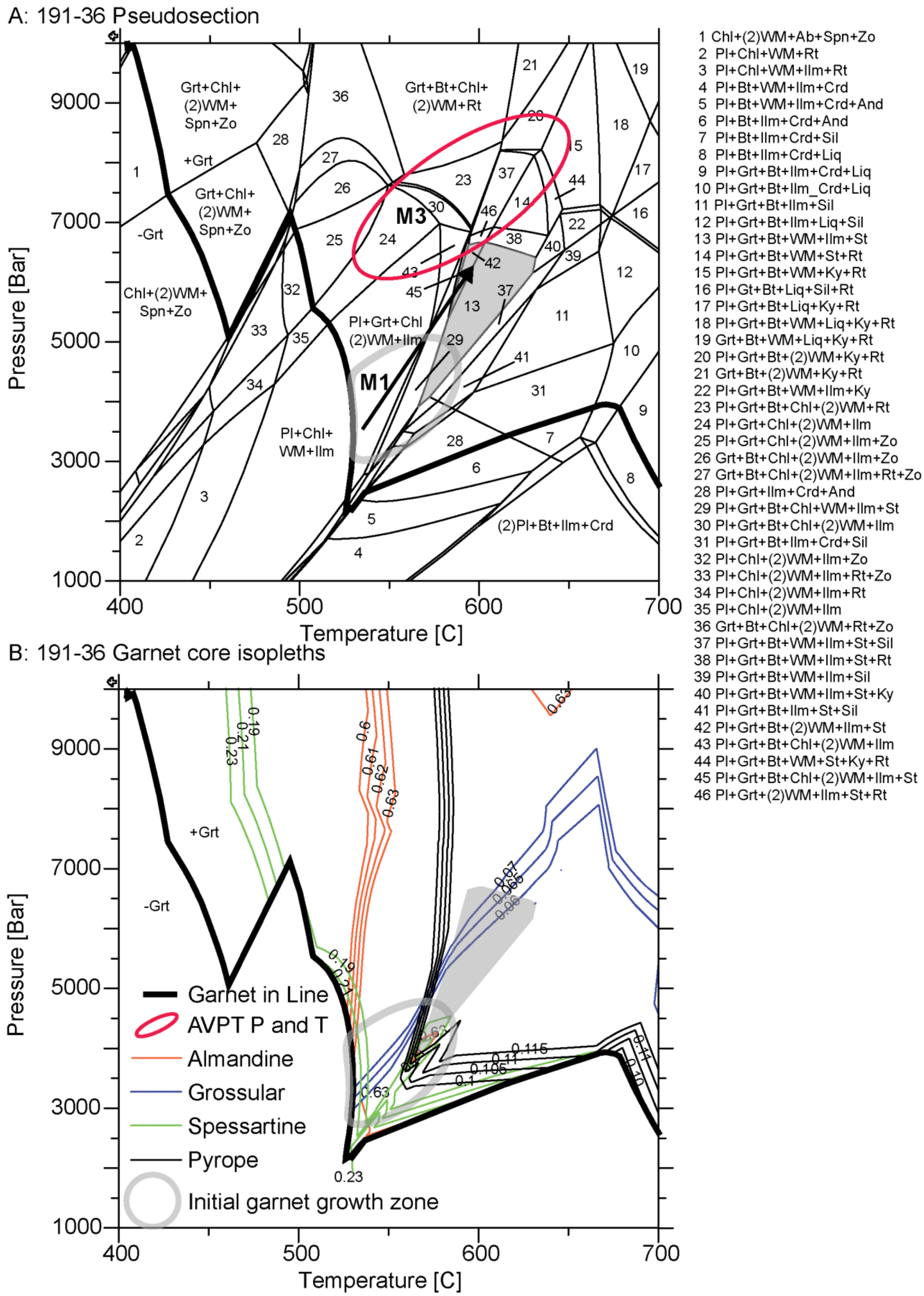


Figure 16

A) Pressure-temperature pseudosection for sample 191-17b depicting mineral stabilities as a function of pressure and temperature. Stability field for the observed peak mineral assemblage is shaded in gray, garnet stability field to the right of the bold black line, interpreted zone of initiation of garnet growth outlined in gray, and results of average pressure and temperature calculations in red (Table 6). Average pressure and temperature error plotted as 1 sigma. Arrow indicates the prograde metamorphic path. Interpreted zone of garnet growth initiation outlined in gray. B) Garnet almandine, grossular, pyrope, and spessartine end-member core isopleths. Interpreted zone of garnet growth initiation outlined in gray.



A: 191-36 Pseudosection
Pressure [Bar]
Temperature [C]
Grt+Chl+ (2)WM+ Spn+Zo
Grt+Bt+Chl+ (2)WM+Rt
+Grt
-Grt
Grt+Chl+ (2)WM+ Spn+Zo
Chl+(2)WM+ Spn+Zo
Pl+Grt+Chl (2)WM+Ilm
Pl+Chl+ WM+Ilm
(2)Pl+Bt+Ilm+Crd
M1
M3
B: 191-36 Garnet core isopleths
Pressure [Bar]
Temperature [C]
+Grt
-Grt
Garnet in Line
AVPT P and T
Almandine
Grossular
Spessartine
Pyrope
Initial garnet growth zone
1 Chl+(2)WM+Ab+Spn+Zo
2 Pl+Chl+WM+Rt
3 Pl+Chl+WM+Ilm+Rt
4 Pl+Bt+WM+Ilm+Crd
5 Pl+Bt+WM+Ilm+Crd+And
6 Pl+Bt+Ilm+Crd+And
7 Pl+Bt+Ilm+Crd+Sil
8 Pl+Bt+Ilm+Crd+Liq
9 Pl+Grt+Bt+Ilm+Crd+Liq
10 Pl+Grt+Bt+Ilm_Crd+Liq
11 Pl+Grt+Bt+Ilm+Sil
12 Pl+Grt+Bt+Ilm+Liq+Sil
13 Pl+Grt+Bt+WM+Ilm+St
14 Pl+Grt+Bt+WM+St+Rt
15 Pl+Grt+Bt+WM+Ky+Rt
16 Pl+Gt+Bt+Liq+Sil+Rt
17 Pl+Grt+Bt+Liq+Ky+Rt
18 Pl+Grt+Bt+WM+Liq+Ky+Rt
19 Grt+Bt+WM+Liq+Ky+Rt
20 Pl+Grt+Bt+(2)WM+Ky+Rt
21 Grt+Bt+(2)WM+Ky+Rt
22 Pl+Grt+Bt+WM+Ilm+Ky
23 Pl+Grt+Bt+Chl+(2)WM+Rt
24 Pl+Grt+Chl+(2)WM+Ilm
25 Pl+Grt+Chl+(2)WM+Ilm+Zo
26 Grt+Bt+Chl+(2)WM+Ilm+Zo
27 Grt+Bt+Chl+(2)WM+Ilm+Rt+Zo
28 Pl+Grt+Ilm+Crd+And
29 Pl+Grt+Bt+Chl+WM+Ilm+St
30 Pl+Grt+Bt+Chl+(2)WM+Ilm
31 Pl+Grt+Bt+Ilm+Crd+Sil
32 Pl+Chl+(2)WM+Ilm+Zo
33 Pl+Chl+(2)WM+Ilm+Rt+Zo
34 Pl+Chl+(2)WM+Ilm+Rt
35 Pl+Chl+(2)WM+Ilm
36 Grt+Bt+Chl+(2)WM+Rt+Zo
37 Pl+Grt+Bt+WM+Ilm+St+Sil
38 Pl+Grt+Bt+WM+Ilm+St+Rt
39 Pl+Grt+Bt+WM+Ilm+Sil
40 Pl+Grt+Bt+WM+Ilm+St+Ky
41 Pl+Grt+Bt+Ilm+St+Sil
42 Pl+Grt+Bt+(2)WM+Ilm+St
43 Pl+Grt+Bt+Chl+(2)WM+Ilm
44 Pl+Grt+Bt+WM+St+Ky+Rt
45 Pl+Grt+Bt+Chl+(2)WM+Ilm+St
46 Pl+Grt+(2)WM+Ilm+St+Rt

Figure 17

A) Pressure-temperature pseudosection for sample 191-36 depicting mineral stabilities as a function of pressure and temperature. Stability field for the observed peak mineral assemblage is shaded in gray, garnet stability field to the right of the bold black line, interpreted zone of initiation of garnet growth outlined in gray, and results of average pressure and temperature calculations in red (Table 6). Arrow indicates the prograde metamorphic path. Average pressure and temperature error plotted as 1 sigma. Interpreted zone of garnet growth initiation circled in gray. B) Garnet almandine, grossular, pyrope, and spessartine end-member core isopleths. Interpreted zone of garnet growth initiation circled in gray.

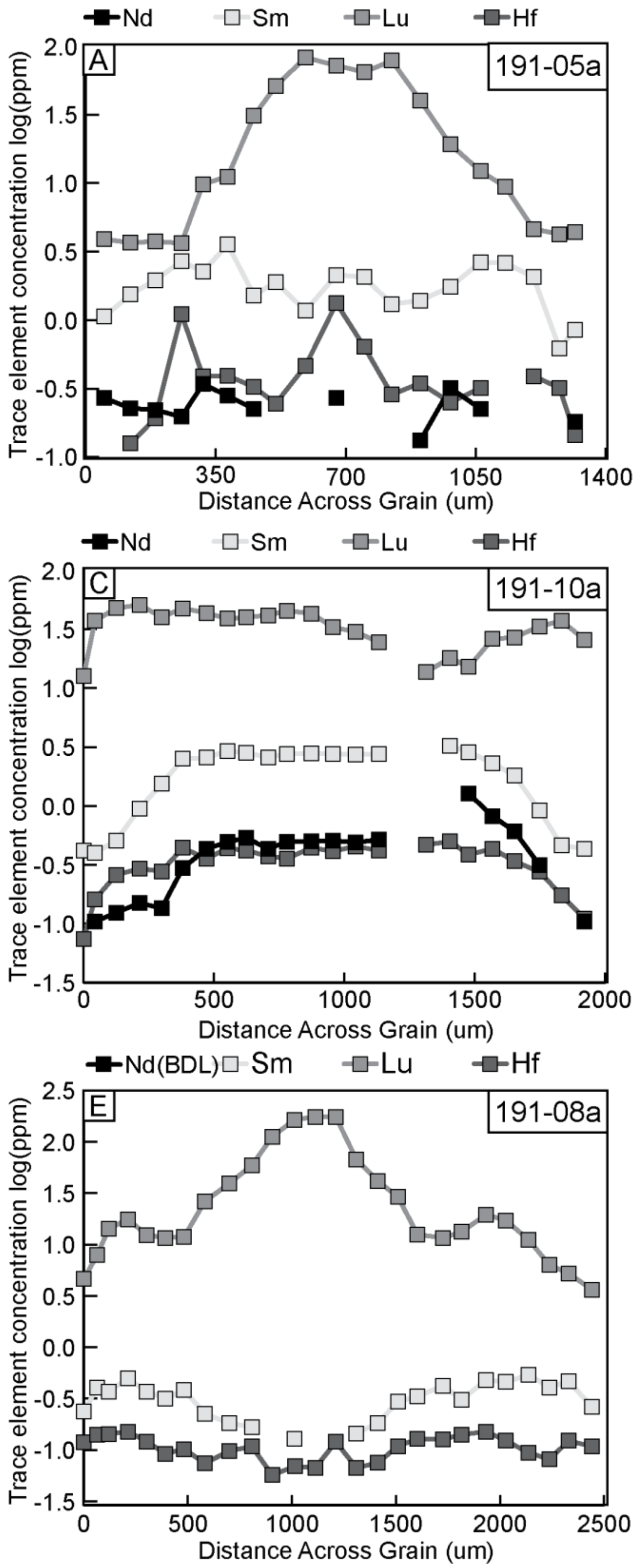
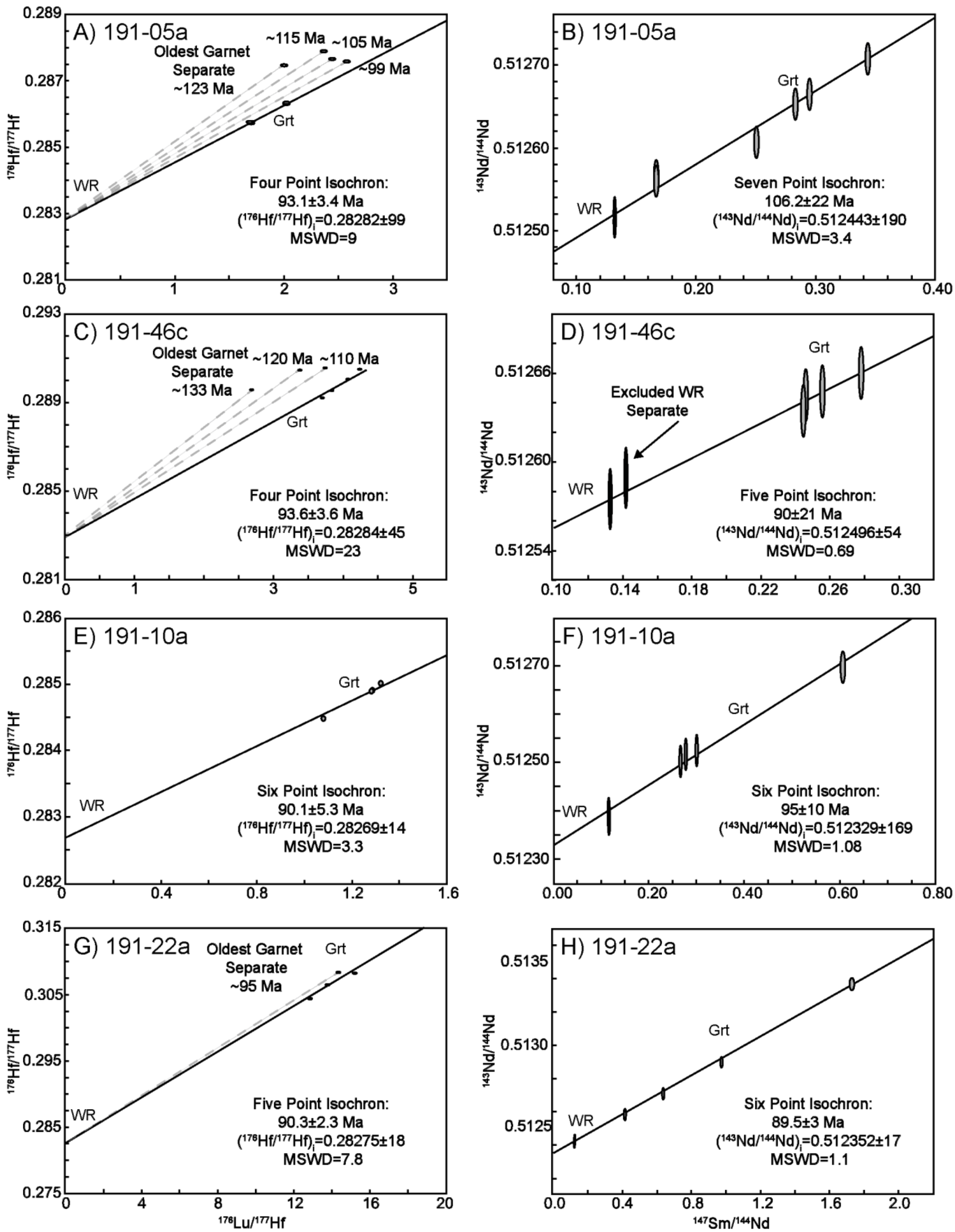
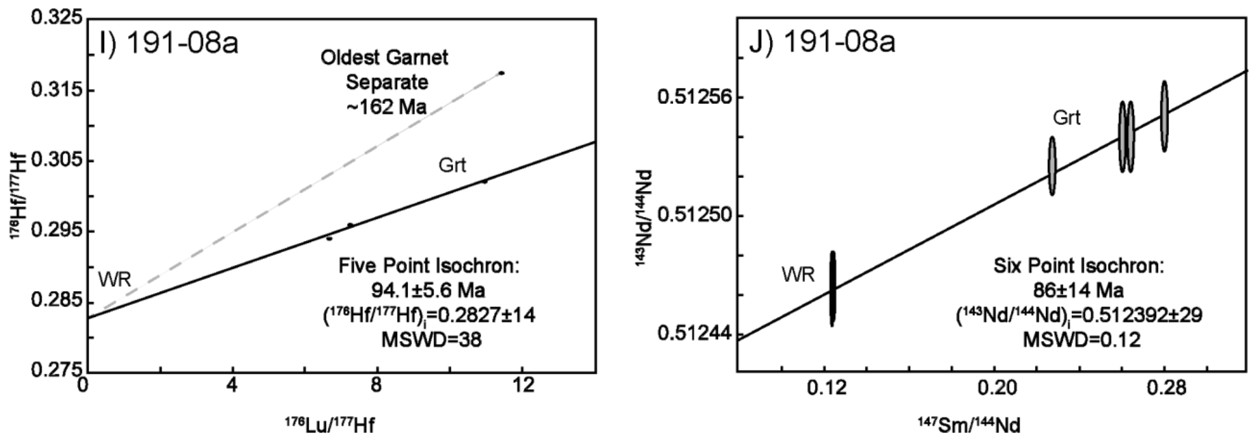

Nd
Sm
Lu
Hf
A
191-05a
B
191-46c
C
191-10a
D
191-22a
Nd(BDL)
E
191-08a
Trace element concentration log(ppm)
Distance Across Grain (um)

Figure 18

Garnet trace element concentrations from the Chiwaukum schist. Concentrations are plotted as a log function to facilitate viewing. A) Trace element transect concentrations for sample 191-05a. B) Trace element transect concentrations for sample 191-46c. C) Trace element transect concentrations for sample 191-10a. D) Trace element transect concentrations for sample 191-22a E) Trace element transect concentrations for sample 191-08a. BDL – Below Detection Limit


A) 191-05a
Oldest Garnet Separate ~123 Ma
~115 Ma
~105 Ma
~99 Ma
Grt
WR
Four Point Isochron:
93.1±3.4 Ma
(^{176}Hf/^{177}Hf)$_i$=0.28282±99
MSWD=9
B) 191-05a
Grt
WR
Seven Point Isochron:
106.2±22 Ma
(^{143}Nd/^{144}Nd)$_i$=0.512443±190
MSWD=3.4
C) 191-46c
Oldest Garnet Separate ~133 Ma
~120 Ma
~110 Ma
Grt
WR
Four Point Isochron:
93.6±3.6 Ma
(^{176}Hf/^{177}Hf)$_i$=0.28284±45
MSWD=23
D) 191-46c
Grt
Excluded WR Separate
WR
Five Point Isochron:
90±21 Ma
(^{143}Nd/^{144}Nd)$_i$=0.512496±54
MSWD=0.69
E) 191-10a
Grt
WR
Six Point Isochron:
90.1±5.3 Ma
(^{176}Hf/^{177}Hf)$_i$=0.28269±14
MSWD=3.3
F) 191-10a
Grt
WR
Six Point Isochron:
95±10 Ma
(^{143}Nd/^{144}Nd)$_i$=0.512329±169
MSWD=1.08
G) 191-22a
Oldest Garnet Separate ~95 Ma
Grt
WR
Five Point Isochron:
90.3±2.3 Ma
(^{176}Hf/^{177}Hf)$_i$=0.28275±18
MSWD=7.8
H) 191-22a
Grt
WR
Six Point Isochron:
89.5±3 Ma
(^{143}Nd/^{144}Nd)$_i$=0.512352±17
MSWD=1.1
^{176}Hf/^{177}Hf
^{143}Nd/^{144}Nd
^{176}Lu/^{177}Hf
^{147}Sm/^{144}Nd



I) 191-08a
Oldest Garnet Separate ~162 Ma
Grt
WR
Five Point Isochron: 94.1±5.6 Ma
(^{176}Hf/^{177}Hf)$_i$=0.2827±14
MSWD=38
^{176}Hf/^{177}Hf
^{176}Lu/^{177}Hf
J) 191-08a
Grt
WR
Six Point Isochron: 86±14 Ma
(^{143}Nd/^{144}Nd)$_i$=0.512392±29
MSWD=0.12
^{143}Nd/^{144}Nd
^{147}Sm/^{144}Nd

Figure 19

Garnet Lu-Hf and Sm-Nd isochron ages from the Chiwaukum schist. Isotopic data summarized in Table 9 and 10. A) Scattered Lu-Hf ratios of sample 191-05a. B) Sm-Nd isochron for sample 191-05a. C) Scattered Lu-Hf ratios of sample 191-46c. D) Sm-Nd isochron for sample 191-46c. E) Lu-Hf isochron for sample 191-10a. F) Sm-Nd isochron for sample 191-10a. G) Lu-Hf isochron for sample 191-22a. I) Sm-Nd isochron for sample 191-22a. J) Lu-Hf isochron for sample 191-08a.K) Sm-Nd isochron for sample 191-08a.

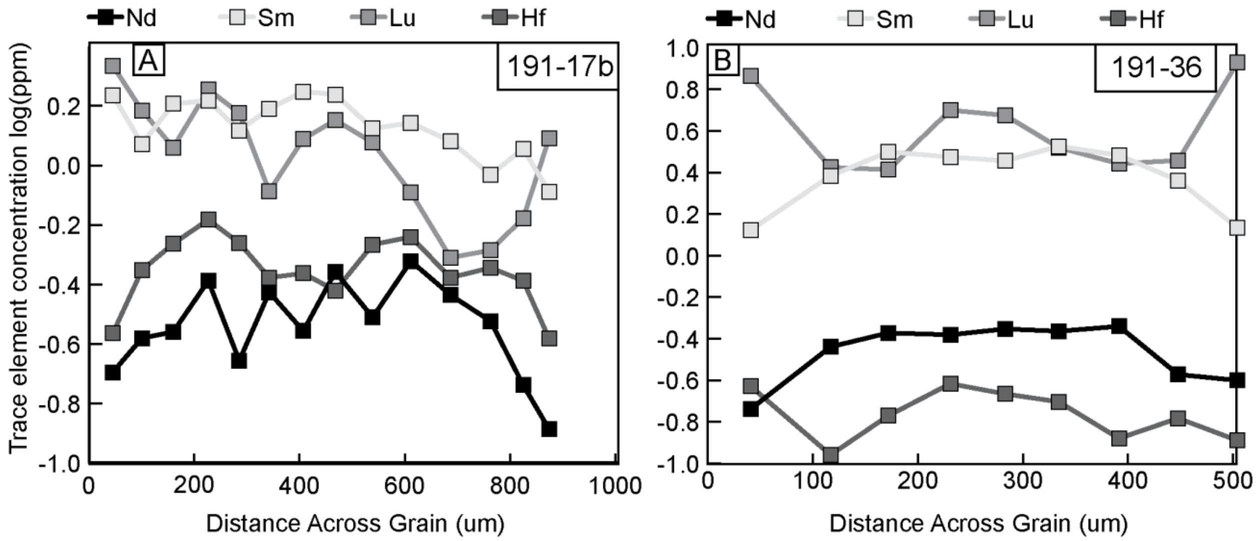
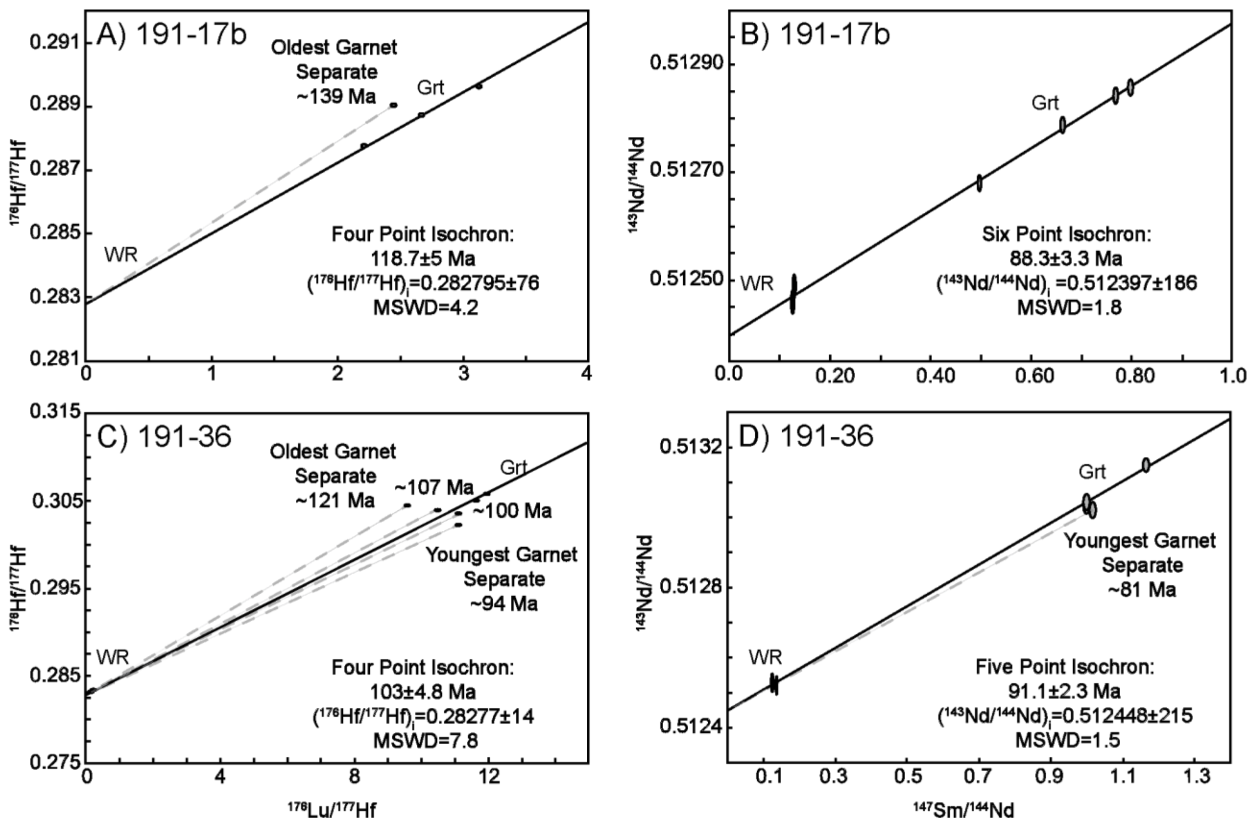

Nd
Sm
Lu
Hf
A
191-17b
Trace element concentration log(ppm)
Distance Across Grain (um)
B
191-36
Distance Across Grain (um)

Figure 20

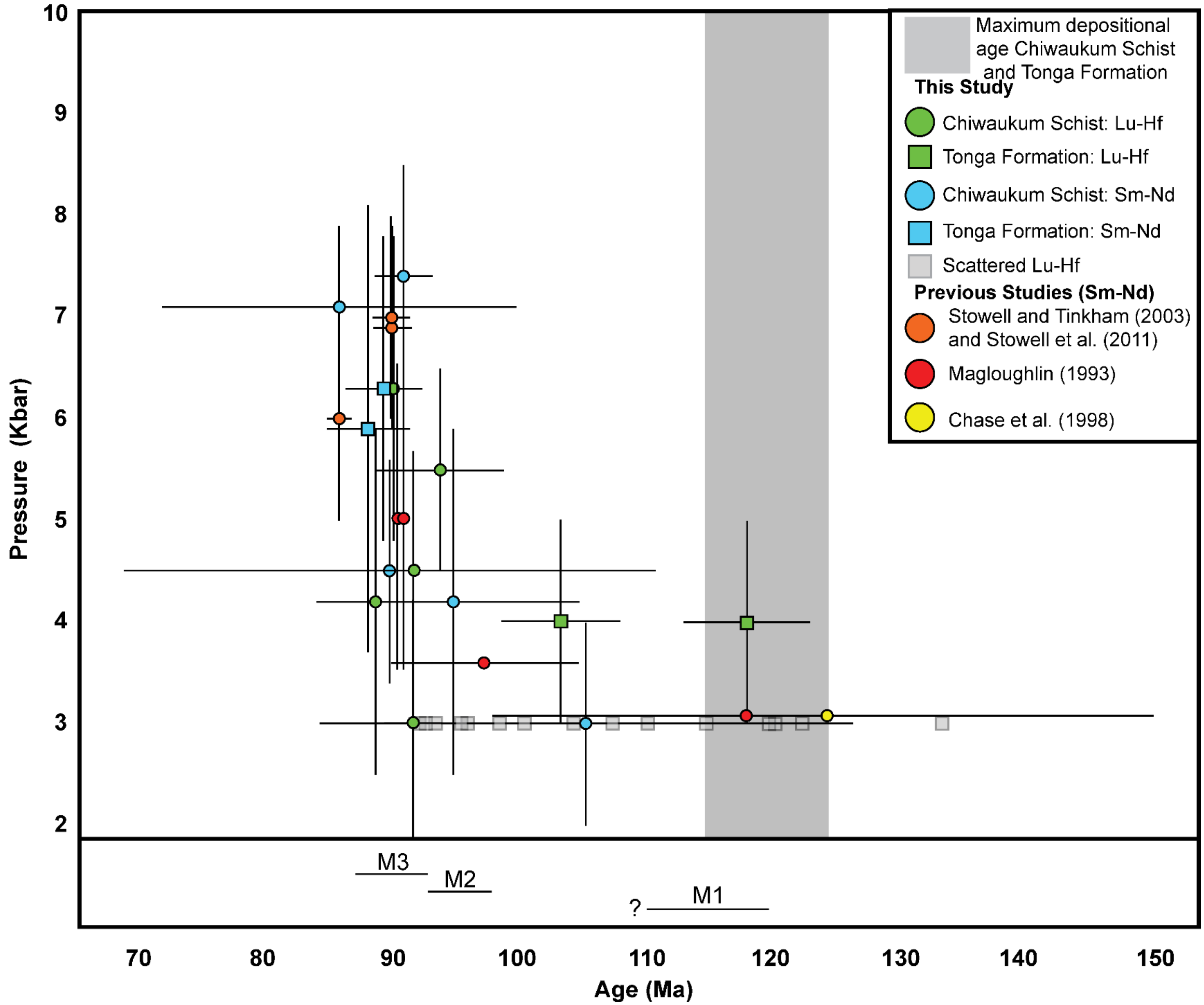
Garnet trace element concentrations from the Tonga formation. Concentrations are plotted as a log function to facilitate viewing. A) Sample 191-17b from within the M2 contact aureole of the Beckler peak pluton. B) Sample 191-36 from M3 staurolite-bearing assemblages.



A) 191-17b
Oldest Garnet Separate ~139 Ma
Grt
WR
Four Point Isochron:
118.7±5 Ma
(176Hf/177Hf)i=0.282795±76
MSWD=4.2
176Hf/177Hf
B) 191-17b
Grt
WR
Six Point Isochron:
88.3±3.3 Ma
(143Nd/144Nd)i =0.512397±186
MSWD=1.8
143Nd/144Nd
C) 191-36
Oldest Garnet Separate ~121 Ma
~107 Ma
Grt
~100 Ma
Youngest Garnet Separate ~94 Ma
WR
Four Point Isochron:
103±4.8 Ma
(176Hf/177Hf)i=0.28277±14
MSWD=7.8
176Lu/177Hf
D) 191-36
Grt
Youngest Garnet Separate ~81 Ma
WR
Five Point Isochron:
91.1±2.3 Ma
(143Nd/144Nd)i=0.512448±215
MSWD=1.5
147Sm/144Nd

Figure 21

Garnet Lu-Hf and Sm-Nd isochron ages from the Tonga formation. Isotopic data summarized in Table 9 and 10. A) Lu-Hf isochron for sample 191-17b. B) Sm-Nd isochron for sample 191-17b. C) Scattered Lu-Hf ratios of sample 191-36. D) Sm-Nd isochron for sample 191-36.



Pressure (Kbar)
10
9
8
7
6
5
4
3
2
Age (Ma)
70
80
90
100
110
120
130
140
150
M3
M2
? M1
Maximum depositional age Chiwaukum Schist and Tonga Formation
This Study
Chiwaukum Schist: Lu-Hf
Tonga Formation: Lu-Hf
Chiwaukum Schist: Sm-Nd
Tonga Formation: Sm-Nd
Scattered Lu-Hf
Previous Studies (Sm-Nd)
Stowell and Tinkham (2003) and Stowell et al. (2011)
Magloughlin (1993)
Chase et al. (1998)

Figure 22

Pressure versus time plot of garnet Lu-Hf and Sm-Nd ages from this study and Sm-Nd ages from the literature (Table 11). Pressure conditions for the Lu-Hf ages are linked with the intersection pressure of the garnet core isopleths from Figures 11-17. A standard error of plus/minus one kbar is used for these pressure estimates. Pressure conditions for new Sm-Nd ages were calculated using the AveragePT function in Thermocalc (Table 6). Pressure conditions for the ages from Magloughlin and Edwards (1999) and Chase et al. (1998) are estimated from data presented in Evans and Davidson (1999) and from known pressure conditions for the metamorphic event the ages fall within.

APPENDIX 1 MINERAL SEPARATION TECHNIQUES

Mineral separation techniques

Standard mineral separation techniques were followed and performed at Western Washington University and included crushing with a jaw crusher, hand separation of garnet from the matrix using a variety of hand tools (pliers, chisels, etc.), magnetic separation with a Frantz Magnetic Separator, and final sample purification using a stereo macroscope to obtain pure inclusion free garnet fractions.

Four garnet and two garnet free whole-rock fractions from each sample, averaging 250 mg, were taken to the Radiogenic Isotope and Geochronology Laboratory (RIGL) at Washington State University for dissolution, separation, and purification of the elements of interest. Each fraction was first sonicated in 1 molar hydrochloric acid and rinsed several times in MQH_2O to remove any remaining accessory phases. These rinsed samples were then dissolved in a multistep process using concentrated hydrofluoric, nitric, hydrochloric, and orthoboric acid to ensure complete dissociation of target elements following procedures discussed in the appendix of Johnson et al. (2018). Dissolution of garnet and one whole-rock fraction were performed using table top hotplates aimed at complete garnet-matrix digestion while leaving behind Hf bearing phases like zircon, which may not be in isotopic equilibrium with garnet and can erroneously skew the Lu-Hf isotopic data resulting in an improper interpretation of the age of the samples metamorphic history (Scherer et al., 2000). The Sm-Nd isotopic data can also be similarly by the presence of Sm-Nd rich phases including monazite and apatite (Baxter et al., 2017). The remaining ~250 mg whole-rock fraction was dissolved in a pressurized, steel-jacketed PTFE (Teflon) dissolution vessel at 150ºC for approximately ten days to digest all phases, including zircon, to analyze the effect of all phases on the final Lu/Hf and Hf/Hf ratios. This fraction was then subjected to the same dissolution process as all other fractions to insure complete dissociation of all elements.

Once dissolved, samples were spiked with a known mass of ^{176}Lu-^{180}Hf and ^{149}Sm-^{150}Nd tracer solutions. Target elements were then separated with ion exchange chromatography using a three step process for Hf, and a two-step process for Lu, Sm, and Nd that uses organic cation exchange resins following procedures presented in Patchett and Tatsumoto (1980), Vervoort and Patchett (1996), Vervoort et al. (2004) and updated by Johnson et al. (2018). Chemically isolated elements from each fraction were analyzed using a Thermo Scientific Neptune Plus multi-collector inductively coupled plasma mass-spectrometer housed in the Radiogenic Isotope and Geochronology Laboratory at Washington State University. Samples were analyzed using the standard-sample-standard bracketing method that allows for readjustment of samples and standards relative to accepted standard values using JMC 475 Hf ($^{176}Hf/^{177}Hf$=0.282160) and JNdi-1 ($^{143}Nd/^{144}Nd$= 0.512115) (Vervoort and Blichert-Toft, 1999; Tanaka et al., 2000).

Lu-Hf and Sm-Nd ages were calculated with a ^{176}Lu decay constant of 1.867×10^{-11} a^{-1} (Söderlund et al., 2004) and ^{147}Sm decay constant of 6.54×10^{-12} a^{-1} (Lugmair and Marti, 1978). Isochrons were plotted using the online version of IsoplotR (Vermeesch, 2018) with in-run uncertainty expressed as 2σ standard error and the associated 95% confidence interval. Epsilon Hf and Nd values were calculated using present day CHUR values of $^{176}Hf/^{178}Hf$=0.282785, $^{176}Lu/^{177}Hf$=0.0336, $^{143}Nd/^{144}Nd$=0.512630, and $^{147}Sm/^{144}Nd$=0.1960 (Bouvier et al., 2008)).

TABLE 1 SAMPLE LOCATIONS

Sample Name	Latitude	Logitude
191-003	47.52817	-120.81967
191-004	47.60662	-120.88640
191-005	47.60759	-120.91672
191-007	47.77066	-120.92687
191-008	47.78161	-120.93381
191-009	47.73934	-121.04819
191-010	47.71970	-121.11610
191-011	47.81636	-121.29733
191-012	47.77887	-121.29663
191-013	47.79629	-121.29398
191-014	47.80375	-121.29176
191-016	47.72049	-121.30890
191-017A	47.72828	-121.31302
191-017B	47.72830	-121.31275
191-018	47.53889	-120.80893
191-019	47.60727	-120.88513
191-020	47.60533	-120.91698
191-021	47.86147	-121.10547
191-022	47.86070	-121.10529
191-023	47.80184	-121.29190
191-024	47.79589	-121.28569
191-025	47.79290	-121.27786
191-026	47.79579	-121.27638
191-027	47.79011	-121.26346
191-028	47.83692	-121.31586
191-029	47.81375	-121.31223
191-030	47.85013	-121.30817
191-031	47.85620	-121.31200
191-033	47.88053	-121.32198
191-034	47.88558	-121.32408
191-035	47.87409	-121.31474
191-036	47.86782	-121.31038
191-037	47.86220	-121.28448
191-038	47.85600	-121.29413
191-040	47.78682	-121.28105
191-041	47.76443	-121.26084
191-042	47.73183	-121.30954
191-043	47.72675	-121.29639
191-044	47.82449	-121.03334
191-045	47.85097	-120.83164
191-046	47.53975	-120.86597
191-047	47.73512	-121.13070

TABLE 2 SAMPLE MINEROLOGY

Sample	Chl	Bt	Grt	St	Ky	Sil	And	Ms	Crd	Plg	Kfs	Qz	Amp	Ttn	Ilm	Tour	Sp	Gr
191-03a		X	X				X		X	X		X					X	
191-04a	X	X	X							X		X				X		
191-04b	X	X	X							X		X				X		
191-05a	X	X	X							X		X	X					
191-07a	X	X	R	R				X		X		X						
191-08a		X	X	X	X					X		X		X	X			
191-09b	X	X	X	X			X	X		X		X					X	
191-10a	X	x	X							X		X		X	X			
191-10b	X	X					X	X		X		X				X		
191-11a	X	X	X	R						X		X						X
191-12a		X								X		X						X
191-13a		X								X		X						X
191-14b		X	X					X		X		X						X
191-16a	X	X	R	R				?		X		X						X
191-17a		X	X	X		X	X			X		X						
191-17b		X	X	X			X			X		X						X
191-18	X	X	X					X	X	X		X						
191-19a										X		X						
191-20a			X					X		X		X	X					
191-21a		X	X	X		X		X		X		X						
191-22a		X	X	X		X				X		X						
191-23		X								X		X						X
191-24	X	X	R	R				X		X		X						X
191-25	X	X	X	X				X		X		X						
191-26	X	X						X		X		X						X
191-28a	X	X	X	X				X		X		X						X
191-29	X	X	X	X				X		X		X						X
191-30		X	X	X						X		X						X
191-31	X		X					X		X		X	X					
191-32			X							X		X	X					
191-33	X	X	X							X		X						X
191-34a		X	X					X		X		X						X
191-35		X	X							X		X	X					X
191-36	X	X	X	X				X		X		X						X
191-37	X	X		X				X		X		X						X
191-38a		X	X					X		X		X						
191-38b		X	X					X		X		X						X
191-40		X						X		X		X						X
191-41		X	X				X	X		X		X				X		
191-42		X						X		X		X						X
191-43		X		X				X		X		X						X
191-44-1	X	X	X							X		X						
191-44-2	X	X	X					X		X		X						
191-45	X	X	X					X		X		X						

Sample	Chl	Bt	Grt	St	Ky	Sil	And	Ms	Crd	Plg	Kfs	Qz	Amp	Ttn	Ilm	Tour	Sp	Gr
191-46a	X	X	X						X	X		X						
191-46b	X	X	X						X	X		X						
191-46c	X	X	X						X	X		X						
191-47b	X	X	X		X		X	X		X		X						

R=reliced mineral

Mineral abraviations after Whitney and Evans (2010)

TABLE 3A GARNET MAJOR ELEMENT ZONING PROFILES.

191-05a	Oxide percent EDS data						
Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total
10	37.478	21.883	32.898	1.913	3.849	2.145	100.167
20	37.619	22.070	31.575	1.929	4.148	2.192	99.534
30	37.834	22.168	31.967	1.890	4.402	2.250	100.509
40	37.699	22.189	32.039	2.218	4.631	2.232	101.007
50	37.736	22.165	31.950	1.971	4.512	2.178	100.511
60	37.977	21.898	31.521	2.174	4.508	2.137	100.215
70	37.438	21.945	31.145	2.039	4.651	2.072	99.290
80	37.900	21.965	31.567	2.252	4.602	1.946	100.233
90	37.753	21.973	31.825	2.375	4.594	2.036	100.557
100	37.890	21.779	31.666	2.514	4.614	2.195	100.659
110	37.793	22.057	31.495	2.239	4.806	2.031	100.421
120	37.605	22.067	31.680	2.592	4.579	1.986	100.510
130	37.707	21.791	30.843	2.496	4.611	2.069	99.518
140	38.001	21.890	31.001	2.796	4.587	2.049	100.323
150	37.768	21.995	30.530	2.564	4.577	2.025	99.459
160	37.377	21.727	30.743	2.610	4.630	1.988	99.075
170	37.611	22.154	31.115	2.656	4.319	1.846	99.700
180	37.451	22.057	31.559	2.786	4.569	1.982	100.404
190	37.627	21.815	31.356	2.619	4.670	1.995	100.082
200	37.656	21.998	31.366	2.765	4.428	1.955	100.168
210	37.610	21.777	31.381	2.782	4.541	1.963	100.054
220	37.705	22.116	30.805	2.818	4.621	1.938	100.005
230	37.821	21.950	31.101	2.794	4.496	2.001	100.163
240	37.495	21.942	30.642	2.827	4.340	1.820	99.066
250	38.208	22.032	30.692	2.676	4.711	2.004	100.323
260	37.659	22.023	31.059	2.734	4.558	1.947	99.980
270	37.775	22.169	31.118	2.884	4.398	1.976	100.320
280	38.046	21.743	31.275	2.910	4.431	1.956	100.361
290	37.789	21.912	30.767	3.076	4.544	1.912	100.001
300	37.367	21.871	31.000	2.875	4.651	1.802	99.565

TABLE 3A GARNET MAJOR ELEMENT ZONING PROFILES.

191-05a			Atomic units				
Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
10	2.982	2.052	2.189	0.129	0.457	0.183	7.992
20	2.993	2.069	2.101	0.130	0.492	0.187	7.972
30	2.984	2.060	2.108	0.126	0.517	0.190	7.986
40	2.965	2.057	2.107	0.148	0.543	0.188	8.007
50	2.977	2.061	2.108	0.132	0.531	0.184	7.992
60	3.001	2.039	2.083	0.145	0.531	0.181	7.980
70	2.983	2.061	2.075	0.138	0.552	0.177	7.986
80	2.994	2.045	2.086	0.151	0.542	0.165	7.983
90	2.980	2.044	2.101	0.159	0.541	0.172	7.997
100	2.989	2.025	2.089	0.168	0.543	0.186	7.999
110	2.981	2.050	2.077	0.150	0.565	0.172	7.994
120	2.971	2.055	2.093	0.173	0.539	0.168	8.001
130	2.998	2.042	2.051	0.168	0.547	0.176	7.981
140	3.000	2.036	2.046	0.187	0.540	0.173	7.982
150	2.999	2.058	2.028	0.172	0.542	0.172	7.972
160	2.988	2.047	2.055	0.177	0.552	0.170	7.989
170	2.987	2.074	2.067	0.179	0.511	0.157	7.976
180	2.965	2.058	2.089	0.187	0.539	0.168	8.006
190	2.983	2.038	2.079	0.176	0.552	0.169	7.998
200	2.983	2.054	2.078	0.186	0.523	0.166	7.990
210	2.985	2.037	2.083	0.187	0.537	0.167	7.996
220	2.984	2.063	2.039	0.189	0.545	0.164	7.984
230	2.992	2.047	2.058	0.187	0.530	0.170	7.984
240	2.995	2.066	2.047	0.191	0.517	0.156	7.972
250	3.007	2.044	2.020	0.178	0.553	0.169	7.971
260	2.984	2.057	2.058	0.184	0.538	0.165	7.987
270	2.985	2.064	2.056	0.193	0.518	0.167	7.983
280	3.007	2.025	2.067	0.195	0.522	0.166	7.981
290	2.994	2.046	2.038	0.206	0.537	0.162	7.983
300	2.977	2.054	2.065	0.194	0.552	0.154	7.996

TABLE 3A GARNET MAJOR ELEMENT ZONING PROFILES.

191-05a	Percent garnet end member					
Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
10	0.740	0.044	0.154	0.062	1.000	0.173
20	0.722	0.045	0.169	0.064	1.000	0.190
30	0.717	0.043	0.176	0.065	1.000	0.197
40	0.706	0.049	0.182	0.063	1.000	0.205
50	0.714	0.045	0.180	0.062	1.000	0.201
60	0.708	0.049	0.181	0.062	1.000	0.203
70	0.705	0.047	0.188	0.060	1.000	0.210
80	0.709	0.051	0.184	0.056	1.000	0.206
90	0.707	0.053	0.182	0.058	1.000	0.205
100	0.700	0.056	0.182	0.062	1.000	0.206
110	0.701	0.050	0.191	0.058	1.000	0.214
120	0.704	0.058	0.181	0.057	1.000	0.205
130	0.697	0.057	0.186	0.060	1.000	0.210
140	0.695	0.063	0.183	0.059	1.000	0.209
150	0.696	0.059	0.186	0.059	1.000	0.211
160	0.696	0.060	0.187	0.058	1.000	0.212
170	0.709	0.061	0.176	0.054	1.000	0.198
180	0.700	0.063	0.181	0.056	1.000	0.205
190	0.699	0.059	0.185	0.057	1.000	0.210
200	0.704	0.063	0.177	0.056	1.000	0.201
210	0.700	0.063	0.181	0.056	1.000	0.205
220	0.694	0.064	0.186	0.056	1.000	0.211
230	0.699	0.064	0.180	0.058	1.000	0.205
240	0.703	0.066	0.178	0.054	1.000	0.202
250	0.692	0.061	0.189	0.058	1.000	0.215
260	0.699	0.062	0.183	0.056	1.000	0.207
270	0.701	0.066	0.177	0.057	1.000	0.201
280	0.701	0.066	0.177	0.056	1.000	0.202
290	0.692	0.070	0.182	0.055	1.000	0.208
300	0.696	0.065	0.186	0.052	1.000	0.211

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
310	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	310	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
320	37.901	21.727	31.224	3.186	4.678	1.922	100.637	320	2.991	2.021	2.061	0.213	0.550	0.163	7.999
330	37.881	21.928	31.322	3.036	4.551	1.877	100.596	330	2.989	2.039	2.067	0.203	0.535	0.159	7.992
340	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	340	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
350	37.926	21.680	31.387	3.021	4.606	1.863	100.484	350	2.997	2.019	2.074	0.202	0.543	0.158	7.993
360	37.532	22.095	31.279	3.143	4.561	1.937	100.547	360	2.967	2.058	2.068	0.210	0.537	0.164	8.004
370	37.855	21.913	31.169	2.903	4.543	1.901	100.284	370	2.993	2.042	2.061	0.194	0.535	0.161	7.986
380	38.075	22.119	31.070	2.949	4.673	1.970	100.855	380	2.990	2.047	2.041	0.196	0.547	0.166	7.986
390	37.560	21.827	31.289	2.793	4.466	1.984	99.919	390	2.984	2.044	2.079	0.188	0.529	0.169	7.994
400	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	400	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
410	37.489	21.658	30.934	3.019	4.368	2.068	99.536	410	2.991	2.036	2.064	0.204	0.519	0.177	7.991
420	37.665	21.820	30.960	2.811	4.499	1.863	99.617	420	2.996	2.045	2.059	0.189	0.533	0.159	7.982
430	37.559	21.902	30.778	2.968	4.410	1.987	99.603	430	2.989	2.054	2.048	0.200	0.523	0.169	7.984
440	37.818	22.118	30.930	3.064	4.461	1.906	100.298	440	2.988	2.059	2.044	0.205	0.525	0.161	7.983
450	37.844	21.925	30.710	3.073	4.596	1.857	100.005	450	2.996	2.046	2.033	0.206	0.542	0.158	7.981
460	37.665	21.955	30.604	2.929	4.535	1.990	99.678	460	2.991	2.055	2.032	0.197	0.537	0.169	7.982
470	37.697	22.450	30.606	2.797	4.485	1.868	99.903	470	2.981	2.093	2.024	0.187	0.529	0.158	7.972
480	37.643	22.050	31.442	2.940	4.548	1.911	100.534	480	2.974	2.053	2.078	0.197	0.536	0.162	7.999
490	37.695	22.216	31.437	2.727	4.490	2.044	100.608	490	2.973	2.065	2.074	0.182	0.528	0.173	7.994
500	38.113	21.851	31.560	2.718	4.464	1.960	100.666	500	3.003	2.029	2.080	0.181	0.524	0.165	7.983
510	37.671	21.852	31.338	2.819	4.431	1.880	99.991	510	2.990	2.044	2.080	0.190	0.524	0.160	7.988
520	37.938	21.653	31.126	2.857	4.595	1.925	100.094	520	3.005	2.021	2.062	0.192	0.543	0.163	7.985
530	37.602	21.945	31.275	2.779	4.473	1.858	99.933	530	2.985	2.053	2.076	0.187	0.529	0.158	7.989
540	37.528	21.759	30.624	2.748	4.706	1.921	99.285	540	2.992	2.044	2.042	0.186	0.559	0.164	7.986
550	37.920	21.796	30.964	2.374	4.712	2.101	99.867	550	3.002	2.034	2.050	0.159	0.556	0.178	7.981
560	37.864	22.062	31.194	2.449	4.482	2.095	100.146	560	2.993	2.055	2.062	0.164	0.528	0.177	7.980
570	37.327	22.243	31.612	2.590	4.428	2.092	100.292	570	2.958	2.077	2.095	0.174	0.523	0.178	8.004
580	38.196	21.766	31.661	2.368	4.603	1.946	100.541	580	3.009	2.021	2.086	0.158	0.541	0.164	7.980
590	37.440	21.852	31.417	2.568	4.632	2.044	99.952	590	2.974	2.046	2.087	0.173	0.549	0.174	8.003
600	37.773	21.981	31.759	2.393	4.662	2.207	100.775	600	2.976	2.041	2.093	0.160	0.548	0.186	8.003
610	37.586	22.103	31.593	2.068	4.522	2.193	100.065	610	2.977	2.063	2.093	0.139	0.534	0.186	7.991
620	37.991	22.060	31.824	2.217	4.422	1.961	100.475	620	2.996	2.050	2.099	0.148	0.520	0.166	7.979

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
310	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
320	0.690	0.071	0.184	0.054	1.000	0.211
330	0.697	0.068	0.181	0.054	1.000	0.206
340	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
350	0.697	0.068	0.182	0.053	1.000	0.207
360	0.694	0.071	0.180	0.055	1.000	0.206
370	0.698	0.066	0.181	0.055	1.000	0.206
380	0.692	0.067	0.185	0.056	1.000	0.211
390	0.701	0.063	0.178	0.057	1.000	0.203
400	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
410	0.696	0.069	0.175	0.060	1.000	0.201
420	0.700	0.064	0.181	0.054	1.000	0.206
430	0.696	0.068	0.178	0.058	1.000	0.203
440	0.696	0.070	0.179	0.055	1.000	0.205
450	0.692	0.070	0.185	0.054	1.000	0.211
460	0.692	0.067	0.183	0.058	1.000	0.209
470	0.698	0.065	0.182	0.055	1.000	0.207
480	0.699	0.066	0.180	0.054	1.000	0.205
490	0.701	0.062	0.179	0.058	1.000	0.203
500	0.705	0.061	0.178	0.056	1.000	0.201
510	0.704	0.064	0.178	0.054	1.000	0.201
520	0.697	0.065	0.183	0.055	1.000	0.208
530	0.704	0.063	0.179	0.054	1.000	0.203
540	0.692	0.063	0.190	0.056	1.000	0.215
550	0.696	0.054	0.189	0.061	1.000	0.213
560	0.703	0.056	0.180	0.061	1.000	0.204
570	0.705	0.059	0.176	0.060	1.000	0.200
580	0.707	0.054	0.183	0.056	1.000	0.206
590	0.700	0.058	0.184	0.058	1.000	0.208
600	0.701	0.053	0.183	0.062	1.000	0.207
610	0.709	0.047	0.181	0.063	1.000	0.203
620	0.716	0.050	0.177	0.056	1.000	0.199

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
630	37.581	21.933	31.412	2.044	4.476	2.019	99.465	630	2.991	2.057	2.091	0.138	0.531	0.172	7.980
640	37.585	21.956	32.510	1.876	4.485	2.122	100.534	640	2.973	2.047	2.150	0.126	0.529	0.180	8.004
650	37.744	22.161	32.245	1.798	4.458	2.094	100.501	650	2.979	2.061	2.128	0.120	0.525	0.177	7.990
660	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	660	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
670	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	670	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
680	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	680	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

TABLE 3B GARNET MAJOR ELEMENT ZONING PROFILES. TABLE 3B GARNET MAJOR ELEMENT ZONING PROFILES.

191-08a								191-08a			Atomic units				
Distance	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	total
10	37.452	21.663	32.039	3.049	2.602	2.863	99.667	10	3.006	2.049	2.150	0.207	0.311	0.246	7.970
20	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	20	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
30	37.460	21.674	31.587	1.907	3.446	3.643	99.716	30	2.991	2.039	2.109	0.129	0.410	0.312	7.990
40	37.964	21.856	31.428	1.758	3.176	3.931	100.114	40	3.011	2.043	2.085	0.118	0.376	0.334	7.967
50	37.675	21.341	31.556	1.413	3.400	4.580	99.965	50	3.001	2.004	2.102	0.095	0.404	0.391	7.997
60	37.419	21.647	31.393	1.194	3.278	4.299	99.230	60	2.996	2.043	2.102	0.081	0.391	0.369	7.982
70	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	70	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
80	37.539	21.593	31.692	0.990	3.314	4.756	99.886	80	2.991	2.027	2.111	0.067	0.394	0.406	7.996
90	38.039	21.597	31.682	0.824	3.236	4.838	100.216	90	3.014	2.017	2.099	0.055	0.382	0.411	7.978
100	37.964	21.847	31.693	0.946	2.940	5.045	100.435	100	3.004	2.037	2.097	0.063	0.347	0.428	7.977
110	37.921	21.798	31.945	0.780	3.058	5.072	100.573	110	2.999	2.032	2.113	0.052	0.360	0.430	7.985
120	37.594	21.611	31.386	0.905	2.789	5.271	99.556	120	3.003	2.035	2.097	0.061	0.332	0.451	7.979
130	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	130	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
140	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	140	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
150	37.488	21.654	31.857	0.724	2.799	5.031	99.553	150	2.998	2.041	2.130	0.049	0.334	0.431	7.982
160	37.626	21.787	31.617	0.968	2.545	4.975	99.518	160	3.007	2.052	2.113	0.066	0.303	0.426	7.967
170	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	170	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
180	37.624	21.855	31.600	0.974	2.544	5.351	99.950	180	2.997	2.052	2.105	0.066	0.302	0.457	7.978
190	37.777	21.516	31.967	1.238	2.667	5.085	100.250	190	3.006	2.018	2.127	0.083	0.316	0.434	7.985
200	37.145	21.663	31.354	0.969	2.590	5.030	98.751	200	2.994	2.058	2.113	0.066	0.311	0.434	7.977
210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
630	0.713	0.047	0.181	0.059	1.000	0.203
640	0.720	0.042	0.177	0.060	1.000	0.197
650	0.721	0.041	0.178	0.060	1.000	0.198
660	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
670	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
680	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

TABLE 3B GARNET MAJOR ELEMENT ZONING PROFILES.

191-08a	Percent garnet end member					
Distance	Alm	Sps	Py	Grs	Total	XMg
10	0.738	0.071	0.107	0.084	1.000	0.126
20	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
30	0.713	0.044	0.139	0.105	1.000	0.163
40	0.716	0.041	0.129	0.115	1.000	0.153
50	0.703	0.032	0.135	0.131	1.000	0.161
60	0.714	0.028	0.133	0.125	1.000	0.157
70	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
80	0.709	0.022	0.132	0.136	1.000	0.157
90	0.712	0.019	0.130	0.139	1.000	0.154
100	0.715	0.022	0.118	0.146	1.000	0.142
110	0.715	0.018	0.122	0.145	1.000	0.146
120	0.713	0.021	0.113	0.153	1.000	0.137
130	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
140	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
150	0.724	0.017	0.113	0.146	1.000	0.135
160	0.727	0.023	0.104	0.146	1.000	0.125
170	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
180	0.719	0.022	0.103	0.156	1.000	0.126
190	0.719	0.028	0.107	0.146	1.000	0.129
200	0.722	0.023	0.106	0.149	1.000	0.128
210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
220	37.540	21.520	31.834	1.047	2.668	4.941	99.550	220	3.005	2.030	2.131	0.071	0.318	0.424	7.980
230	37.273	21.764	31.684	1.292	2.833	5.091	99.936	230	2.976	2.048	2.116	0.087	0.337	0.436	8.000
240	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	240	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
260	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	260	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
270	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	270	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
280	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	280	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
290	37.363	21.826	31.636	1.594	2.586	4.811	99.816	290	2.987	2.056	2.115	0.108	0.308	0.412	7.985
300	37.830	21.357	31.693	1.676	2.582	5.031	100.170	300	3.015	2.006	2.112	0.113	0.307	0.430	7.982
310	37.526	21.927	31.615	1.825	2.525	4.901	100.318	310	2.986	2.056	2.104	0.123	0.299	0.418	7.986
320	36.852	21.729	31.233	1.887	2.475	4.936	99.112	320	2.972	2.065	2.106	0.129	0.297	0.426	7.996
330	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	330	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
340	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	340	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
350	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	350	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
360	37.759	21.810	31.095	1.999	2.197	4.918	99.779	360	3.014	2.052	2.076	0.135	0.261	0.421	7.960
370	37.318	21.731	30.837	2.246	2.357	4.988	99.478	370	2.993	2.054	2.069	0.153	0.282	0.429	7.979
380	37.495	21.531	30.886	2.104	2.275	4.993	99.284	380	3.011	2.038	2.075	0.143	0.272	0.430	7.969
390	36.969	22.129	31.392	2.305	2.283	4.710	99.788	390	2.963	2.090	2.104	0.157	0.273	0.404	7.992
400	37.399	21.275	31.048	2.324	2.206	4.811	99.063	400	3.016	2.022	2.094	0.159	0.265	0.416	7.973
410	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	410	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
420	37.120	21.685	30.655	2.504	2.326	4.832	99.121	420	2.990	2.059	2.065	0.171	0.279	0.417	7.981
430	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	430	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
440	37.604	21.543	30.746	2.626	2.262	4.755	99.535	440	3.014	2.035	2.061	0.178	0.270	0.408	7.968
450	37.473	21.775	30.497	2.482	2.374	5.077	99.679	450	2.997	2.053	2.040	0.168	0.283	0.435	7.976
460	37.905	21.971	30.477	2.624	2.325	5.165	100.467	460	3.005	2.053	2.021	0.176	0.275	0.439	7.968
470	37.902	21.460	30.484	3.017	2.351	5.200	100.414	470	3.015	2.012	2.028	0.203	0.279	0.443	7.979
480	37.400	21.849	30.211	2.838	2.292	5.182	99.773	480	2.991	2.059	2.020	0.192	0.273	0.444	7.980
490	37.421	21.949	30.674	2.768	2.237	5.129	100.522	490	2.974	2.056	2.039	0.186	0.265	0.437	7.977
500	37.596	21.547	30.768	2.703	2.194	4.938	99.746	500	3.010	2.033	2.060	0.183	0.262	0.424	7.973
510	37.158	21.623	30.469	3.013	2.234	5.094	99.592	510	2.985	2.047	2.047	0.205	0.268	0.439	7.991
520	37.465	21.474	30.719	2.794	2.135	5.016	99.604	520	3.007	2.031	2.062	0.190	0.256	0.431	7.977
530	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	530	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
220	0.724	0.024	0.108	0.144	1.000	0.130
230	0.711	0.029	0.113	0.146	1.000	0.137
240	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
260	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
270	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
280	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
290	0.719	0.037	0.105	0.140	1.000	0.127
300	0.713	0.038	0.104	0.145	1.000	0.127
310	0.715	0.042	0.102	0.142	1.000	0.125
320	0.712	0.044	0.101	0.144	1.000	0.124
330	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
340	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
350	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
360	0.718	0.047	0.090	0.145	1.000	0.112
370	0.706	0.052	0.096	0.146	1.000	0.120
380	0.711	0.049	0.093	0.147	1.000	0.116
390	0.716	0.053	0.093	0.138	1.000	0.115
400	0.714	0.054	0.090	0.142	1.000	0.112
410	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
420	0.704	0.058	0.095	0.142	1.000	0.119
430	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
440	0.706	0.061	0.093	0.140	1.000	0.116
450	0.697	0.057	0.097	0.149	1.000	0.122
460	0.694	0.061	0.094	0.151	1.000	0.120
470	0.687	0.069	0.094	0.150	1.000	0.121
480	0.690	0.066	0.093	0.152	1.000	0.119
490	0.697	0.064	0.091	0.149	1.000	0.115
500	0.703	0.063	0.089	0.145	1.000	0.113
510	0.692	0.069	0.090	0.148	1.000	0.116
520	0.702	0.065	0.087	0.147	1.000	0.110
530	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
540	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	540	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
550	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	550	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
560	37.324	21.490	30.059	3.275	2.344	4.762	99.253	560	3.003	2.038	2.023	0.223	0.281	0.410	7.978
570	37.400	21.464	30.974	3.246	2.285	4.707	100.075	570	2.995	2.026	2.074	0.220	0.273	0.404	7.992
580	37.454	22.022	30.424	2.850	2.335	4.641	99.725	580	2.993	2.074	2.033	0.193	0.278	0.397	7.970
590	37.753	21.397	29.868	3.004	2.227	4.844	99.092	590	3.033	2.026	2.007	0.204	0.267	0.417	7.954
600	37.506	21.490	30.645	3.080	2.223	4.713	100.028	600	2.997	2.024	2.048	0.208	0.265	0.404	7.968
610	37.243	21.739	30.796	3.172	2.099	4.972	100.023	610	2.983	2.052	2.063	0.215	0.251	0.427	7.991
620	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	620	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
630	38.091	21.866	30.508	3.343	2.099	5.186	101.093	630	3.010	2.036	2.016	0.224	0.247	0.439	7.972
640	37.104	21.557	30.343	3.132	2.078	5.114	99.328	640	2.990	2.047	2.045	0.214	0.250	0.441	7.987
650	37.583	21.381	30.229	3.416	1.978	5.195	99.781	650	3.014	2.021	2.027	0.232	0.236	0.446	7.976
660	37.555	21.756	29.378	3.845	2.052	5.161	99.747	660	3.005	2.051	1.966	0.261	0.245	0.442	7.970
670	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	670	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
680	37.337	21.238	29.271	4.154	1.947	5.360	99.307	680	3.010	2.018	1.973	0.284	0.234	0.463	7.981
690	36.950	21.449	27.966	4.002	1.808	5.462	99.018	690	3.013	2.062	1.907	0.276	0.220	0.477	7.956
700	37.451	21.797	28.892	4.413	1.902	5.389	99.844	700	2.997	2.056	1.934	0.299	0.227	0.462	7.975
710	37.284	21.492	29.481	4.401	1.818	5.693	100.169	710	2.988	2.030	1.976	0.299	0.217	0.489	7.998
720	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	720	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
730	37.561	21.372	28.317	4.932	1.875	5.878	99.935	730	3.008	2.017	1.896	0.335	0.224	0.504	7.984
740	37.523	21.542	28.017	4.820	1.983	5.859	99.744	740	3.004	2.033	1.876	0.327	0.237	0.503	7.979
750	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	750	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
760	37.642	21.402	29.025	5.006	1.838	5.623	100.535	760	3.003	2.013	1.937	0.338	0.219	0.481	7.990
770	37.971	21.265	27.754	4.868	1.908	5.689	99.454	770	3.042	2.008	1.859	0.330	0.228	0.488	7.955
780	37.435	21.519	28.219	4.874	1.763	5.917	99.726	780	3.003	2.034	1.893	0.331	0.211	0.509	7.980
790	36.958	21.595	27.857	5.038	1.640	5.877	98.964	790	2.989	2.058	1.884	0.345	0.198	0.509	7.982
800	37.130	21.522	27.994	5.145	1.652	6.108	99.552	800	2.989	2.042	1.884	0.351	0.198	0.527	7.991
810	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	810	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
820	37.806	21.506	27.632	5.165	1.725	5.953	99.787	820	3.023	2.027	1.848	0.350	0.206	0.510	7.963
830	37.272	21.355	27.697	5.417	1.667	6.009	99.418	830	3.002	2.027	1.866	0.370	0.200	0.519	7.984
840	37.117	21.452	27.919	5.282	1.780	5.898	99.447	840	2.990	2.037	1.881	0.360	0.214	0.509	7.991
850	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	850	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
540	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
550	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
560	0.689	0.076	0.096	0.140	1.000	0.122
570	0.698	0.074	0.092	0.136	1.000	0.116
580	0.701	0.066	0.096	0.137	1.000	0.120
590	0.693	0.071	0.092	0.144	1.000	0.117
600	0.700	0.071	0.091	0.138	1.000	0.114
610	0.698	0.073	0.085	0.144	1.000	0.108
620	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
630	0.689	0.076	0.085	0.150	1.000	0.109
640	0.693	0.072	0.085	0.150	1.000	0.109
650	0.689	0.079	0.080	0.152	1.000	0.104
660	0.675	0.089	0.084	0.152	1.000	0.111
670	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
680	0.668	0.096	0.079	0.157	1.000	0.106
690	0.662	0.096	0.076	0.166	1.000	0.103
700	0.662	0.102	0.078	0.158	1.000	0.105
710	0.663	0.100	0.073	0.164	1.000	0.099
720	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
730	0.641	0.113	0.076	0.170	1.000	0.106
740	0.638	0.111	0.080	0.171	1.000	0.112
750	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
760	0.651	0.114	0.073	0.162	1.000	0.101
770	0.640	0.114	0.078	0.168	1.000	0.109
780	0.643	0.112	0.072	0.173	1.000	0.100
790	0.642	0.118	0.067	0.173	1.000	0.095
800	0.637	0.118	0.067	0.178	1.000	0.095
810	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
820	0.634	0.120	0.071	0.175	1.000	0.100
830	0.632	0.125	0.068	0.176	1.000	0.097
840	0.635	0.122	0.072	0.172	1.000	0.102
850	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
860	37.749	21.460	27.802	5.357	1.766	5.972	100.107	860	3.015	2.020	1.857	0.362	0.210	0.511	7.975
870	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	870	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
880	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	880	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
890	37.427	21.219	27.431	5.540	1.644	5.916	99.177	890	3.019	2.017	1.850	0.378	0.198	0.511	7.973
900	37.277	21.401	27.541	5.871	1.704	5.755	99.550	900	3.000	2.030	1.854	0.400	0.204	0.496	7.985
910	37.136	21.476	27.099	5.795	1.743	6.096	99.345	910	2.992	2.039	1.826	0.395	0.209	0.526	7.988
920	37.354	21.469	27.040	5.658	1.653	5.893	99.067	920	3.011	2.040	1.823	0.386	0.199	0.509	7.969
930	37.438	21.310	26.816	6.013	1.714	5.984	99.275	930	3.014	2.022	1.806	0.410	0.206	0.516	7.974
940	37.527	21.484	27.178	5.667	1.564	6.074	99.495	940	3.014	2.034	1.826	0.386	0.187	0.523	7.969
950	38.036	21.980	27.000	5.970	1.600	6.232	100.817	950	3.010	2.050	1.787	0.400	0.189	0.528	7.965
960	37.686	21.574	26.915	5.670	1.576	6.314	99.734	960	3.016	2.035	1.801	0.384	0.188	0.541	7.966
970	37.384	21.623	27.171	6.178	1.596	6.155	100.107	970	2.992	2.040	1.819	0.419	0.190	0.528	7.988
980	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	980	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
990	37.247	21.380	27.292	6.130	1.624	6.185	99.857	990	2.993	2.024	1.834	0.417	0.194	0.532	7.995
1000	37.112	21.455	26.706	6.178	1.568	6.075	99.094	1000	2.998	2.042	1.804	0.423	0.189	0.526	7.981
1010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1010	2.997	2.053	1.840	0.393	0.184	0.510	7.977
1020	37.797	21.814	26.672	6.210	1.557	6.206	100.256	1020	3.010	2.047	1.776	0.419	0.185	0.530	7.967
1030	37.082	21.417	26.538	6.511	1.457	6.067	99.072	1030	2.998	2.041	1.795	0.446	0.176	0.526	7.981
1040	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1040	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1050	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1050	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1060	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1060	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1070	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1070	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1080	37.328	21.564	26.625	6.717	1.505	6.192	99.930	1080	2.994	2.038	1.786	0.456	0.180	0.532	7.987
1090	37.934	21.758	26.795	6.338	1.555	5.973	100.685	1090	3.008	2.033	1.777	0.426	0.184	0.507	7.955
1100	37.385	21.773	27.122	6.221	1.540	6.088	100.130	1100	2.990	2.052	1.814	0.421	0.184	0.522	7.984
1110	37.108	21.517	26.533	6.548	1.454	6.199	99.360	1110	2.993	2.045	1.790	0.447	0.175	0.536	7.985
1120	37.111	21.589	26.507	6.606	1.457	6.033	99.303	1120	2.993	2.052	1.788	0.451	0.175	0.521	7.981
1130	37.817	21.545	27.000	6.568	1.575	6.288	100.793	1130	3.006	2.019	1.795	0.442	0.187	0.536	7.984
1140	37.058	21.338	26.699	6.375	1.554	6.243	99.267	1140	2.993	2.031	1.803	0.436	0.187	0.540	7.991
1150	37.147	21.300	26.921	6.411	1.545	6.293	99.617	1150	2.993	2.023	1.814	0.437	0.186	0.543	7.996
1160	36.904	21.133	26.664	6.090	1.557	6.133	98.482	1160	3.002	2.026	1.814	0.420	0.189	0.535	7.985
1170	37.130	21.575	26.651	6.279	1.495	6.061	99.190	1170	2.996	2.052	1.798	0.429	0.180	0.524	7.978

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
860	0.631	0.123	0.071	0.174	1.000	0.102
870	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
880	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
890	0.630	0.129	0.067	0.174	1.000	0.097
900	0.627	0.135	0.069	0.168	1.000	0.099
910	0.617	0.134	0.071	0.178	1.000	0.103
920	0.625	0.132	0.068	0.174	1.000	0.098
930	0.615	0.140	0.070	0.176	1.000	0.102
940	0.625	0.132	0.064	0.179	1.000	0.093
950	0.615	0.138	0.065	0.182	1.000	0.096
960	0.618	0.132	0.064	0.186	1.000	0.094
970	0.615	0.142	0.064	0.179	1.000	0.095
980	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
990	0.616	0.140	0.065	0.179	1.000	0.096
1000	0.613	0.144	0.064	0.179	1.000	0.095
1010	0.629	0.134	0.063	0.174	1.000	0.091
1020	0.611	0.144	0.064	0.182	1.000	0.094
1030	0.610	0.152	0.060	0.179	1.000	0.089
1040	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1050	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1060	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1070	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1080	0.605	0.154	0.061	0.180	1.000	0.092
1090	0.614	0.147	0.064	0.175	1.000	0.094
1100	0.617	0.143	0.062	0.177	1.000	0.092
1110	0.607	0.152	0.059	0.182	1.000	0.089
1120	0.609	0.154	0.060	0.178	1.000	0.089
1130	0.607	0.149	0.063	0.181	1.000	0.094
1140	0.608	0.147	0.063	0.182	1.000	0.094
1150	0.609	0.147	0.062	0.182	1.000	0.093
1160	0.613	0.142	0.064	0.181	1.000	0.094
1170	0.614	0.146	0.061	0.179	1.000	0.091

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
1180	37.430	21.402	26.840	6.307	1.554	6.224	99.758	1180	3.005	2.025	1.802	0.429	0.186	0.535	7.982
1190	37.310	21.345	26.749	6.216	1.426	6.174	99.219	1190	3.010	2.030	1.805	0.425	0.171	0.534	7.975
1200	37.417	21.571	26.808	6.531	1.470	6.089	99.886	1200	3.001	2.039	1.798	0.444	0.176	0.523	7.980
1210	37.428	21.715	26.640	6.229	1.649	5.989	99.649	1210	3.001	2.052	1.786	0.423	0.197	0.514	7.973
1220	37.168	21.668	26.787	6.270	1.477	6.121	99.492	1220	2.991	2.055	1.803	0.427	0.177	0.528	7.981
1230	37.285	21.601	26.482	6.025	1.482	6.187	99.063	1230	3.006	2.052	1.786	0.411	0.178	0.534	7.968
1240	37.092	21.062	26.818	6.214	1.709	6.140	99.036	1240	3.003	2.009	1.816	0.426	0.206	0.533	7.993
1250	37.204	21.527	26.816	6.326	1.460	6.061	99.394	1250	2.998	2.044	1.807	0.432	0.175	0.523	7.980
1260	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1260	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1270	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1270	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1280	37.316	21.667	26.884	6.411	1.587	6.037	99.902	1280	2.992	2.047	1.802	0.435	0.190	0.519	7.985
1290	37.468	21.510	27.262	5.911	1.632	6.315	100.097	1290	2.998	2.029	1.824	0.401	0.195	0.541	7.988
1300	36.707	21.594	26.644	6.182	1.508	6.055	98.690	1300	2.979	2.066	1.809	0.425	0.183	0.527	7.988
1310	37.453	21.405	26.787	5.941	1.633	5.925	99.144	1310	3.017	2.032	1.805	0.405	0.196	0.511	7.967
1320	37.173	21.481	26.468	6.347	1.668	6.075	99.213	1320	2.997	2.041	1.785	0.433	0.200	0.525	7.982
1330	37.313	21.391	27.036	6.120	1.726	6.186	99.772	1330	2.996	2.024	1.816	0.416	0.207	0.532	7.991
1340	37.375	21.499	27.658	5.807	1.602	6.081	100.022	1340	2.996	2.031	1.854	0.394	0.191	0.522	7.989
1350	37.623	21.782	27.028	5.957	1.506	6.043	99.940	1350	3.007	2.052	1.807	0.403	0.179	0.518	7.967
1360	37.395	21.237	27.258	5.795	1.609	6.075	99.369	1360	3.013	2.017	1.837	0.395	0.193	0.524	7.979
1370	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1370	3.024	2.035	1.808	0.398	0.188	0.506	7.959
1380	37.421	21.268	27.397	5.794	1.678	5.884	99.442	1380	3.012	2.018	1.844	0.395	0.201	0.508	7.979
1390	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1390	3.007	2.010	1.839	0.415	0.203	0.513	7.988
1400	37.096	21.932	27.382	5.771	1.545	5.998	99.723	1400	2.978	2.075	1.838	0.392	0.185	0.516	7.985
1410	37.767	21.399	27.834	5.683	1.596	5.833	100.112	1410	3.020	2.016	1.861	0.385	0.190	0.500	7.972
1420	37.268	21.414	27.647	5.593	1.668	6.109	99.699	1420	2.996	2.029	1.859	0.381	0.200	0.526	7.990
1430	37.562	21.690	27.348	5.769	1.610	5.940	99.920	1430	3.005	2.045	1.830	0.391	0.192	0.509	7.972
1440	37.592	21.616	27.533	5.833	1.534	5.966	100.074	1440	3.006	2.038	1.842	0.395	0.183	0.511	7.975
1450	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1450	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1460	37.198	21.538	27.400	5.679	1.646	5.970	99.431	1460	2.995	2.044	1.845	0.387	0.198	0.515	7.983
1470	37.023	21.409	27.690	5.505	1.634	6.072	99.332	1470	2.989	2.037	1.869	0.376	0.197	0.525	7.993
1480	37.711	21.322	27.487	5.574	1.666	5.972	99.732	1480	3.023	2.014	1.843	0.378	0.199	0.513	7.970
1490	37.483	21.410	27.973	5.264	1.673	5.969	99.772	1490	3.007	2.025	1.877	0.358	0.200	0.513	7.980

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
1180	0.610	0.145	0.063	0.181	1.000	0.094
1190	0.615	0.145	0.058	0.182	1.000	0.087
1200	0.611	0.151	0.060	0.178	1.000	0.089
1210	0.612	0.145	0.067	0.176	1.000	0.099
1220	0.614	0.146	0.060	0.180	1.000	0.089
1230	0.614	0.141	0.061	0.184	1.000	0.091
1240	0.609	0.143	0.069	0.179	1.000	0.102
1250	0.615	0.147	0.060	0.178	1.000	0.088
1260	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1270	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1280	0.612	0.148	0.064	0.176	1.000	0.095
1290	0.616	0.135	0.066	0.183	1.000	0.096
1300	0.615	0.144	0.062	0.179	1.000	0.092
1310	0.619	0.139	0.067	0.175	1.000	0.098
1320	0.606	0.147	0.068	0.178	1.000	0.101
1330	0.611	0.140	0.070	0.179	1.000	0.102
1340	0.626	0.133	0.065	0.176	1.000	0.094
1350	0.622	0.139	0.062	0.178	1.000	0.090
1360	0.623	0.134	0.066	0.178	1.000	0.095
1370	0.624	0.137	0.065	0.174	1.000	0.094
1380	0.626	0.134	0.068	0.172	1.000	0.098
1390	0.619	0.140	0.068	0.173	1.000	0.099
1400	0.627	0.134	0.063	0.176	1.000	0.091
1410	0.634	0.131	0.065	0.170	1.000	0.093
1420	0.627	0.128	0.067	0.177	1.000	0.097
1430	0.626	0.134	0.066	0.174	1.000	0.095
1440	0.628	0.135	0.062	0.174	1.000	0.090
1450	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1460	0.626	0.132	0.067	0.175	1.000	0.097
1470	0.630	0.127	0.066	0.177	1.000	0.095
1480	0.628	0.129	0.068	0.175	1.000	0.097
1490	0.637	0.121	0.068	0.174	1.000	0.096

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
1500	37.290	20.958	27.992	5.145	1.725	5.963	99.073	1500	3.016	1.998	1.894	0.352	0.208	0.517	7.985
1510	37.124	21.416	27.552	5.185	1.679	5.630	98.586	1510	3.008	2.045	1.867	0.356	0.203	0.489	7.969
1520	37.163	21.341	27.771	4.891	1.828	5.898	98.891	1520	3.004	2.033	1.877	0.335	0.220	0.511	7.980
1530	37.276	21.792	28.038	4.881	1.731	5.920	99.638	1530	2.990	2.060	1.881	0.332	0.207	0.509	7.979
1540	37.325	21.521	28.354	4.936	1.739	5.947	99.822	1540	2.995	2.035	1.903	0.335	0.208	0.511	7.988
1550	37.109	21.318	28.429	4.867	1.826	5.891	99.440	1550	2.992	2.026	1.917	0.332	0.219	0.509	7.995
1560	37.558	21.478	28.751	4.638	1.911	5.536	99.872	1560	3.008	2.027	1.926	0.315	0.228	0.475	7.979
1570	36.516	21.542	28.846	4.505	1.965	5.841	99.214	1570	2.956	2.055	1.953	0.309	0.237	0.507	8.016
1580	37.489	21.617	29.011	4.321	1.745	5.731	99.915	1580	3.002	2.040	1.943	0.293	0.208	0.492	7.978
1590	37.202	21.473	28.727	4.321	1.824	5.727	99.274	1590	2.998	2.039	1.936	0.295	0.219	0.495	7.982
1600	37.460	21.710	28.309	4.378	1.930	5.725	99.513	1600	3.003	2.051	1.898	0.297	0.231	0.492	7.972
1610	37.205	21.724	28.780	4.207	1.809	5.424	99.149	1610	2.997	2.063	1.939	0.287	0.217	0.468	7.971
1620	37.028	21.664	29.278	4.135	1.896	5.552	99.552	1620	2.980	2.055	1.970	0.282	0.227	0.479	7.993
1630	37.380	21.156	29.288	4.508	1.925	5.548	99.805	1630	3.005	2.004	1.969	0.307	0.231	0.478	7.993
1640	37.660	21.557	29.355	3.909	1.992	5.463	99.936	1640	3.011	2.031	1.962	0.265	0.237	0.468	7.974
1650	37.389	21.486	29.277	3.832	1.967	5.342	99.293	1650	3.008	2.037	1.970	0.261	0.236	0.461	7.973
1660	37.516	21.340	29.750	3.768	1.975	5.543	99.893	1660	3.007	2.016	1.994	0.256	0.236	0.476	7.985
1670	37.152	21.598	29.386	3.428	2.034	5.443	99.042	1670	2.996	2.052	1.982	0.234	0.245	0.470	7.978
1680	37.339	21.423	29.888	3.709	2.000	5.165	99.524	1680	3.003	2.031	2.010	0.253	0.240	0.445	7.982
1690	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1690	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1700	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1700	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1710	36.956	21.535	29.978	3.453	2.021	5.344	99.287	1710	2.982	2.048	2.023	0.236	0.243	0.462	7.994
1720	37.489	21.341	30.317	3.365	2.245	5.390	100.147	1720	2.998	2.012	2.028	0.228	0.268	0.462	7.996
1730	37.316	21.554	30.183	3.165	2.218	5.080	99.516	1730	2.997	2.040	2.027	0.215	0.266	0.437	7.983
1740	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1740	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1750	37.581	21.590	31.032	2.827	2.186	4.963	100.179	1750	3.001	2.032	2.073	0.191	0.260	0.425	7.982
1760	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1760	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1770	37.610	21.543	30.541	2.857	2.056	5.025	99.631	1770	3.015	2.035	2.047	0.194	0.246	0.432	7.968
1780	37.319	21.522	30.783	2.637	2.183	4.977	99.422	1780	3.000	2.039	2.070	0.180	0.262	0.429	7.980
1790	37.816	21.055	31.107	2.685	2.079	4.806	99.549	1790	3.038	1.993	2.090	0.183	0.249	0.414	7.966
1800	36.802	21.418	31.131	2.611	2.301	4.893	99.156	1800	2.976	2.041	2.105	0.179	0.277	0.424	8.003
1810	37.575	21.496	30.897	2.470	2.321	4.689	99.449	1810	3.015	2.033	2.073	0.168	0.278	0.403	7.969

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
1500	0.637	0.119	0.070	0.174	1.000	0.099
1510	0.641	0.122	0.070	0.168	1.000	0.098
1520	0.638	0.114	0.075	0.174	1.000	0.105
1530	0.642	0.113	0.071	0.174	1.000	0.099
1540	0.643	0.113	0.070	0.173	1.000	0.099
1550	0.644	0.112	0.074	0.171	1.000	0.103
1560	0.654	0.107	0.078	0.161	1.000	0.106
1570	0.650	0.103	0.079	0.169	1.000	0.108
1580	0.662	0.100	0.071	0.167	1.000	0.097
1590	0.658	0.100	0.074	0.168	1.000	0.102
1600	0.650	0.102	0.079	0.169	1.000	0.108
1610	0.666	0.099	0.075	0.161	1.000	0.101
1620	0.666	0.095	0.077	0.162	1.000	0.103
1630	0.660	0.103	0.077	0.160	1.000	0.105
1640	0.669	0.090	0.081	0.160	1.000	0.108
1650	0.673	0.089	0.081	0.157	1.000	0.107
1660	0.673	0.086	0.080	0.161	1.000	0.106
1670	0.676	0.080	0.083	0.160	1.000	0.110
1680	0.682	0.086	0.081	0.151	1.000	0.107
1690	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1700	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1710	0.683	0.080	0.082	0.156	1.000	0.107
1720	0.679	0.076	0.090	0.155	1.000	0.117
1730	0.688	0.073	0.090	0.148	1.000	0.116
1740	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1750	0.703	0.065	0.088	0.144	1.000	0.112
1760	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1770	0.701	0.066	0.084	0.148	1.000	0.107
1780	0.704	0.061	0.089	0.146	1.000	0.112
1790	0.712	0.062	0.085	0.141	1.000	0.106
1800	0.705	0.060	0.093	0.142	1.000	0.116
1810	0.710	0.057	0.095	0.138	1.000	0.118

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
1820	37.280	21.393	30.823	2.498	2.428	4.991	99.413	1820	2.998	2.027	2.073	0.170	0.291	0.430	7.989
1830	37.504	21.642	30.583	2.040	2.296	5.010	99.076	1830	3.013	2.049	2.055	0.139	0.275	0.431	7.962
1840	37.385	21.364	31.538	1.725	2.251	4.869	99.133	1840	3.012	2.029	2.125	0.118	0.270	0.420	7.974
1850	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1850	3.025	2.034	2.086	0.132	0.267	0.413	7.958
1860	37.343	21.496	31.287	1.785	2.584	5.016	99.511	1860	2.996	2.032	2.099	0.121	0.309	0.431	7.988
1870	37.260	21.880	31.518	1.661	2.399	4.975	99.693	1870	2.983	2.065	2.110	0.113	0.286	0.427	7.984
1880	37.255	21.410	32.267	2.070	2.585	4.891	100.476	1880	2.977	2.016	2.156	0.140	0.308	0.419	8.015
1890	37.335	21.565	31.833	1.512	2.473	4.859	99.578	1890	2.995	2.039	2.136	0.103	0.296	0.418	7.986
1900	37.684	21.294	32.154	1.305	2.810	4.761	100.009	1900	3.009	2.004	2.147	0.088	0.335	0.407	7.989
1910	37.281	21.957	31.329	1.138	2.547	4.830	99.083	1910	2.992	2.077	2.103	0.077	0.305	0.415	7.969
1920	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1920	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1930	37.135	21.577	31.880	0.846	2.905	4.758	99.102	1930	2.986	2.045	2.144	0.058	0.348	0.410	7.991
1940	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1940	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1950	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1950	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1960	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1960	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1970	37.620	21.392	32.239	0.982	3.040	4.056	99.328	1970	3.015	2.021	2.161	0.067	0.363	0.348	7.975
1980	37.696	21.629	32.132	0.875	2.973	4.634	99.939	1980	3.003	2.031	2.141	0.059	0.353	0.395	7.982
1990	37.398	21.559	31.552	0.745	2.867	5.144	99.265	1990	2.998	2.037	2.115	0.051	0.343	0.442	7.984
2000	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2000	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2020	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2020	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2030	37.260	21.651	32.013	0.597	3.058	4.742	99.321	2030	2.986	2.045	2.146	0.041	0.365	0.407	7.991
2040	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2040	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2050	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2050	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2060	37.890	21.581	32.403	0.460	2.796	5.002	100.132	2060	3.012	2.022	2.154	0.031	0.331	0.426	7.977
2070	37.156	21.884	31.589	0.497	2.931	5.089	99.146	2070	2.979	2.068	2.118	0.034	0.350	0.437	7.987
2080	37.629	21.489	32.059	0.374	2.991	5.237	99.779	2080	3.001	2.020	2.139	0.025	0.356	0.448	7.989
2090	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2090	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2100	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2100	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2110	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2110	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2120	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2120	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2130	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2130	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
1820	0.699	0.057	0.098	0.145	1.000	0.123
1830	0.709	0.048	0.095	0.149	1.000	0.118
1840	0.724	0.040	0.092	0.143	1.000	0.113
1850	0.720	0.045	0.092	0.143	1.000	0.114
1860	0.709	0.041	0.104	0.146	1.000	0.128
1870	0.719	0.038	0.098	0.145	1.000	0.119
1880	0.713	0.046	0.102	0.139	1.000	0.125
1890	0.724	0.035	0.100	0.141	1.000	0.122
1900	0.721	0.030	0.112	0.137	1.000	0.135
1910	0.725	0.027	0.105	0.143	1.000	0.127
1920	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1930	0.724	0.019	0.118	0.138	1.000	0.140
1940	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1950	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1960	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1970	0.735	0.023	0.124	0.118	1.000	0.144
1980	0.726	0.020	0.120	0.134	1.000	0.142
1990	0.717	0.017	0.116	0.150	1.000	0.139
2000	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2020	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2030	0.725	0.014	0.123	0.138	1.000	0.146
2040	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2050	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2060	0.732	0.011	0.113	0.145	1.000	0.133
2070	0.721	0.011	0.119	0.149	1.000	0.142
2080	0.721	0.009	0.120	0.151	1.000	0.143
2090	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2100	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2110	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2120	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2130	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
2140	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2140	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2150	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2150	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2160	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2160	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2170	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2170	2.964	2.101	2.115	0.036	0.371	0.400	7.986
2180	37.795	21.682	31.493	0.803	3.199	4.834	99.806	2180	3.006	2.032	2.095	0.054	0.379	0.412	7.978
2190	37.414	21.665	30.894	1.331	3.401	4.774	99.480	2190	2.988	2.039	2.063	0.090	0.405	0.408	7.993
2200	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2200	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2220	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2220	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2230	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2230	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

TABLE 3C GARNET MAJOR ELEMENT ZONING PROFILES. TABLE 3C GARNET MAJOR ELEMENT ZONING PROFILES.

191-10a								191-10a			Atomic units				
Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	total
0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
10	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	10	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
20	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	20	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
30	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	30	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
40	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	40	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
50	38.896	22.073	33.818	2.333	3.486	1.789	102.395	50	3.027	2.025	2.201	0.154	0.404	0.149	7.960
60	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	60	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
70	37.657	21.798	33.669	2.714	3.777	1.623	101.239	70	2.979	2.033	2.228	0.182	0.446	0.138	8.004
80	37.357	22.383	34.045	2.268	3.981	1.640	101.674	80	2.942	2.078	2.242	0.151	0.467	0.138	8.019
90	37.805	22.338	33.727	2.347	3.903	1.752	101.872	90	2.965	2.065	2.212	0.156	0.456	0.147	8.002
100	37.623	21.920	33.308	2.255	3.867	1.942	100.915	100	2.978	2.045	2.205	0.151	0.456	0.165	8.000
110	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	110	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
120	36.978	22.667	33.784	2.341	4.047	1.867	101.684	120	2.914	2.105	2.226	0.156	0.475	0.158	8.034
130	37.883	22.820	33.761	1.756	4.032	1.638	101.889	130	2.960	2.101	2.206	0.116	0.470	0.137	7.990
140	37.982	22.288	32.939	2.042	4.145	1.734	101.130	140	2.985	2.065	2.165	0.136	0.486	0.146	7.983
150	37.787	22.560	34.177	2.035	4.149	1.619	102.327	150	2.951	2.076	2.232	0.135	0.483	0.135	8.011
160	37.924	22.130	34.267	1.532	4.331	1.577	101.761	160	2.973	2.045	2.247	0.102	0.506	0.132	8.005
170	38.196	22.777	33.814	2.091	3.672	1.649	102.199	170	2.977	2.092	2.204	0.138	0.427	0.138	7.976

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
2140	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2150	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2160	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2170	0.724	0.012	0.127	0.137	1.000	0.149
2180	0.712	0.018	0.129	0.140	1.000	0.153
2190	0.695	0.030	0.136	0.138	1.000	0.164
2200	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2220	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2230	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

TABLE 3C GARNET MAJOR ELEMENT ZONING PROFILES.

191-10a	Percent garnet end member					
Distance	Alm	Sps	Py	Grs	Total	XMg
0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
10	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
20	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
30	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
40	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
50	0.757	0.053	0.139	0.051	1.000	0.155
60	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
70	0.744	0.061	0.149	0.046	1.000	0.167
80	0.748	0.050	0.156	0.046	1.000	0.172
90	0.744	0.052	0.154	0.050	1.000	0.171
100	0.741	0.051	0.153	0.055	1.000	0.171
110	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
120	0.738	0.052	0.158	0.052	1.000	0.176
130	0.753	0.040	0.160	0.047	1.000	0.176
140	0.738	0.046	0.166	0.050	1.000	0.183
150	0.748	0.045	0.162	0.045	1.000	0.178
160	0.752	0.034	0.169	0.044	1.000	0.184
170	0.758	0.047	0.147	0.047	1.000	0.162

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
180	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	180	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
190	38.533	21.956	33.446	2.099	4.263	1.828	102.126	190	3.004	2.017	2.180	0.139	0.495	0.153	7.988
200	37.750	22.493	33.917	2.010	3.981	1.788	101.939	200	2.957	2.077	2.222	0.133	0.465	0.150	8.004
210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
220	37.920	22.550	33.708	1.947	4.560	1.643	102.328	220	2.953	2.070	2.195	0.128	0.529	0.137	8.012
230	38.015	22.328	33.767	2.049	4.434	1.859	102.452	230	2.961	2.049	2.199	0.135	0.515	0.155	8.015
240	38.273	22.199	33.550	1.809	4.479	1.783	102.093	240	2.983	2.039	2.187	0.119	0.520	0.149	7.998
250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
260	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	260	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
270	38.044	22.202	33.181	2.081	4.356	1.682	101.545	270	2.981	2.050	2.174	0.138	0.509	0.141	7.994
280	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	280	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
290	38.068	22.513	33.996	1.663	4.079	1.837	102.156	290	2.970	2.070	2.218	0.110	0.474	0.154	7.995
300	38.043	22.439	32.033	2.438	4.289	1.701	100.944	300	2.987	2.077	2.104	0.162	0.502	0.143	7.975
310	38.434	22.337	33.649	2.282	3.703	1.848	102.253	310	2.996	2.052	2.194	0.151	0.430	0.154	7.978
320	37.731	21.695	33.055	2.333	4.712	1.719	101.245	320	2.973	2.015	2.178	0.156	0.554	0.145	8.020
330	37.946	22.162	33.526	2.072	3.907	1.742	101.355	330	2.985	2.055	2.205	0.138	0.458	0.147	7.988
340	37.756	22.053	32.870	2.051	4.353	1.848	100.931	340	2.977	2.049	2.167	0.137	0.512	0.156	7.998
350	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	350	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
360	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	360	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
370	37.528	22.564	33.276	2.021	4.635	1.351	101.376	370	2.946	2.088	2.185	0.134	0.542	0.114	8.010
380	38.002	21.308	32.836	2.022	4.537	1.610	100.314	380	3.013	1.991	2.177	0.136	0.536	0.137	7.991
390	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	390	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
400	37.166	23.221	33.353	1.922	4.137	1.759	101.558	400	2.916	2.147	2.188	0.128	0.484	0.148	8.011
410	37.978	21.917	32.737	2.229	4.855	1.963	101.678	410	2.973	2.022	2.143	0.148	0.566	0.165	8.016
420	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	420	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
430	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	430	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
440	38.459	22.219	33.237	2.200	4.325	1.704	102.146	440	2.994	2.039	2.164	0.145	0.502	0.142	7.986
450	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	450	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
460	37.442	21.714	32.621	1.997	4.345	2.053	100.172	460	2.977	2.035	2.169	0.135	0.515	0.175	8.006
470	37.666	21.645	33.250	2.288	4.204	1.688	100.740	470	2.985	2.022	2.204	0.154	0.497	0.143	8.004
480	37.828	22.160	32.871	2.662	4.489	1.847	101.857	480	2.962	2.045	2.153	0.177	0.524	0.155	8.015
490	38.020	22.553	32.456	2.047	4.313	1.626	101.014	490	2.983	2.085	2.129	0.136	0.504	0.137	7.975

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
180	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
190	0.735	0.047	0.167	0.051	1.000	0.185
200	0.748	0.045	0.157	0.051	1.000	0.173
210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
220	0.734	0.043	0.177	0.046	1.000	0.194
230	0.732	0.045	0.171	0.052	1.000	0.190
240	0.735	0.040	0.175	0.050	1.000	0.192
250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
260	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
270	0.734	0.047	0.172	0.048	1.000	0.190
280	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
290	0.750	0.037	0.161	0.052	1.000	0.176
300	0.723	0.056	0.172	0.049	1.000	0.193
310	0.749	0.051	0.147	0.053	1.000	0.164
320	0.718	0.051	0.183	0.048	1.000	0.203
330	0.748	0.047	0.155	0.050	1.000	0.172
340	0.729	0.046	0.172	0.053	1.000	0.191
350	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
360	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
370	0.734	0.045	0.182	0.038	1.000	0.199
380	0.729	0.045	0.180	0.046	1.000	0.198
390	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
400	0.742	0.043	0.164	0.050	1.000	0.181
410	0.709	0.049	0.187	0.054	1.000	0.209
420	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
430	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
440	0.733	0.049	0.170	0.048	1.000	0.188
450	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
460	0.725	0.045	0.172	0.058	1.000	0.192
470	0.735	0.051	0.166	0.048	1.000	0.184
480	0.716	0.059	0.174	0.052	1.000	0.196
490	0.733	0.047	0.174	0.047	1.000	0.191

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
500	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	500	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
510	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	510	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
520	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	520	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
530	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	530	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
540	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	540	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
550	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	550	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
560	38.250	21.920	33.214	2.586	4.159	1.840	101.969	560	2.992	2.021	2.173	0.171	0.485	0.154	7.997
570	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	570	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
580	37.707	23.106	33.447	2.303	4.028	1.747	102.338	580	2.937	2.121	2.179	0.152	0.468	0.146	8.002
590	37.524	22.064	33.257	2.386	4.124	1.819	101.175	590	2.963	2.053	2.196	0.160	0.485	0.154	8.011
600	37.898	21.755	32.680	2.823	3.797	1.701	100.655	600	3.003	2.031	2.165	0.189	0.449	0.144	7.982
610	38.297	21.853	33.872	2.337	3.926	1.662	101.947	610	3.000	2.018	2.219	0.155	0.458	0.140	7.991
620	37.673	21.230	33.331	2.674	4.281	1.761	100.950	620	2.988	1.985	2.211	0.180	0.506	0.150	8.019
630	37.668	22.475	32.726	2.752	4.240	1.921	101.781	630	2.952	2.076	2.145	0.183	0.495	0.161	8.011
640	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	640	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
650	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	650	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
660	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	660	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
670	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	670	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
680	38.056	22.726	33.008	2.725	3.921	2.030	102.466	680	2.961	2.084	2.148	0.180	0.455	0.169	7.997
690	0.000	0.000	0.000	0.000	0.000	0.000		690	#####	#####	#####	#####	#####	#####	#####
700	37.311	21.478	32.805	2.041	4.381	1.792	99.809	700	2.981	2.022	2.192	0.138	0.522	0.153	8.008
710	37.651	22.243	33.101	2.165	4.129	2.078	101.367	710	2.962	2.063	2.178	0.144	0.484	0.175	8.007
720	0.000	0.000	0.000	0.000	0.000	0.000		720	#####	#####	#####	#####	#####	#####	#####
730	37.391	22.424	33.112	2.337	3.732	1.742	100.739	730	2.961	2.093	2.193	0.157	0.441	0.148	7.992
740	38.269	22.082	32.688	2.506	4.086	1.444	101.074	740	3.008	2.046	2.149	0.167	0.479	0.122	7.969
750	37.841	22.246	33.555	2.309	4.307	1.724	101.981	750	2.962	2.052	2.197	0.153	0.503	0.145	8.012
760	36.719	21.311	32.925	2.543	4.039	2.200	99.738	760	2.954	2.020	2.215	0.173	0.484	0.190	8.036
770	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	770	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
780	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	780	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
790	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	790	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
800	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	800	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
810	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	810	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
500	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
510	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
520	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
530	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
540	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
550	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
560	0.728	0.057	0.163	0.052	1.000	0.182
570	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
580	0.740	0.052	0.159	0.050	1.000	0.177
590	0.733	0.053	0.162	0.051	1.000	0.181
600	0.735	0.064	0.152	0.049	1.000	0.172
610	0.747	0.052	0.154	0.047	1.000	0.171
620	0.726	0.059	0.166	0.049	1.000	0.186
630	0.719	0.061	0.166	0.054	1.000	0.188
640	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
650	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
660	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
670	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
680	0.728	0.061	0.154	0.057	1.000	0.175
690	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
700	0.729	0.046	0.174	0.051	1.000	0.192
710	0.730	0.048	0.162	0.059	1.000	0.182
720	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
730	0.746	0.053	0.150	0.050	1.000	0.167
740	0.737	0.057	0.164	0.042	1.000	0.182
750	0.733	0.051	0.168	0.048	1.000	0.186
760	0.723	0.057	0.158	0.062	1.000	0.179
770	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
780	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
790	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
800	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
810	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
820	38.328	21.734	33.399	2.490	4.723	1.687	102.361	820	2.987	1.996	2.177	0.164	0.549	0.141	8.015
830	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	830	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
840	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	840	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
850	37.847	21.778	33.807	2.561	4.514	1.597	102.104	850	2.967	2.012	2.216	0.170	0.528	0.134	8.027
860	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	860	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
870	38.543	22.204	32.666	2.623	3.943	1.762	101.742	870	3.010	2.044	2.134	0.173	0.459	0.147	7.968
880	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	880	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
890	38.452	22.763	32.413	2.652	4.148	1.801	102.229	890	2.984	2.082	2.104	0.174	0.480	0.150	7.975
900	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	900	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
910	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	910	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
920	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	920	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
930	38.209	21.977	32.769	2.725	3.729	1.747	101.156	930	3.008	2.039	2.158	0.182	0.438	0.147	7.972
940	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	940	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
950	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	950	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
960	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	960	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
970	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	970	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
980	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	980	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
990	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	990	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1000	38.368	21.334	31.856	2.835	4.647	1.795	100.835	1000	3.022	1.981	2.098	0.189	0.546	0.151	7.988
1010	38.120	22.464	32.645	2.624	3.874	2.041	101.767	1010	2.981	2.071	2.135	0.174	0.452	0.171	7.983
1020	38.124	22.425	32.455	2.634	4.313	1.737	101.689	1020	2.979	2.065	2.121	0.174	0.502	0.145	7.988
1030	38.232	21.982	33.241	2.997	3.897	1.905	102.254	1030	2.989	2.025	2.173	0.198	0.454	0.160	7.999
1040	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1040	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1050	37.768	22.294	32.490	2.801	4.566	1.855	101.774	1050	2.957	2.057	2.127	0.186	0.533	0.156	8.015
1060	37.542	22.126	32.954	2.972	4.385	1.723	101.701	1060	2.951	2.050	2.166	0.198	0.514	0.145	8.024
1070	38.023	22.396	33.478	2.569	3.627	1.973	102.066	1070	2.976	2.066	2.191	0.170	0.423	0.165	7.991
1080	37.851	21.929	32.906	2.511	3.909	1.777	100.884	1080	2.991	2.042	2.175	0.168	0.461	0.150	7.988
1090	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1090	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1100	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1100	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1110	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1110	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1120	38.494	21.798	33.479	3.113	3.676	1.654	102.214	1120	3.011	2.010	2.190	0.206	0.429	0.139	7.984
1130	37.235	22.455	32.953	2.849	4.261	1.815	101.567	1130	2.931	2.083	2.170	0.190	0.500	0.153	8.027

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
820	0.718	0.054	0.181	0.046	1.000	0.201
830	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
840	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
850	0.727	0.056	0.173	0.044	1.000	0.192
860	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
870	0.732	0.060	0.158	0.051	1.000	0.177
880	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
890	0.723	0.060	0.165	0.051	1.000	0.186
900	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
910	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
920	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
930	0.738	0.062	0.150	0.050	1.000	0.169
940	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
950	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
960	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
970	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
980	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
990	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1000	0.703	0.063	0.183	0.051	1.000	0.206
1010	0.728	0.059	0.154	0.058	1.000	0.175
1020	0.721	0.059	0.171	0.049	1.000	0.192
1030	0.728	0.066	0.152	0.053	1.000	0.173
1040	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1050	0.709	0.062	0.178	0.052	1.000	0.200
1060	0.717	0.065	0.170	0.048	1.000	0.192
1070	0.743	0.058	0.143	0.056	1.000	0.162
1080	0.736	0.057	0.156	0.051	1.000	0.175
1090	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1100	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1110	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1120	0.739	0.070	0.145	0.047	1.000	0.164
1130	0.720	0.063	0.166	0.051	1.000	0.187

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
1140	37.977	21.689	33.231	2.689	4.657	1.747	101.990	1140	2.975	2.002	2.177	0.178	0.544	0.147	8.024
1150	37.686	22.113	33.140	2.671	4.523	1.896	102.029	1150	2.952	2.041	2.171	0.177	0.528	0.159	8.028
1160	38.774	22.168	32.074	2.823	4.528	1.647	102.014	1160	3.012	2.030	2.084	0.186	0.524	0.137	7.973
1170	38.788	22.131	32.551	2.976	3.916	2.026	102.389	1170	3.014	2.026	2.115	0.196	0.454	0.169	7.973
1180	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1180	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1190	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1190	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1200	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1200	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1210	38.181	21.742	32.678	3.360	4.218	1.636	101.814	1210	2.994	2.010	2.143	0.223	0.493	0.137	8.001
1220	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1220	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1230	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1230	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1240	37.935	22.059	33.475	2.628	4.512	1.780	102.388	1240	2.961	2.029	2.185	0.174	0.525	0.149	8.024
1250	38.254	21.687	33.388	2.965	4.127	1.781	102.202	1250	2.994	2.000	2.185	0.197	0.481	0.149	8.006
1260	37.839	21.780	32.450	2.887	4.280	1.941	101.177	1260	2.983	2.023	2.139	0.193	0.503	0.164	8.005
1270	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1270	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1280	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1280	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1290	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1290	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1300	37.364	20.936	32.743	3.222	3.929	1.855	100.050	1300	2.995	1.978	2.195	0.219	0.470	0.159	8.016
1310	38.544	21.957	32.622	2.917	4.156	1.836	102.032	1310	3.007	2.019	2.128	0.193	0.483	0.153	7.984
1320	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1320	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1330	37.413	22.438	33.287	3.007	4.517	1.685	102.346	1330	2.926	2.068	2.177	0.199	0.527	0.141	8.039
1340	37.844	21.760	32.194	2.813	4.511	1.932	101.053	1340	2.983	2.021	2.122	0.188	0.530	0.163	8.007
1350	38.176	21.847	32.718	2.583	4.430	1.890	101.643	1350	2.991	2.017	2.144	0.171	0.517	0.159	8.000
1360	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1360	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1370	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1370	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1380	38.168	22.673	32.793	2.562	4.191	1.958	102.346	1380	2.967	2.077	2.132	0.169	0.486	0.163	7.994
1390	38.097	22.528	32.656	2.791	4.365	1.657	102.094	1390	2.969	2.069	2.128	0.184	0.507	0.138	7.996
1400	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1400	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1410	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1410	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1420	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1420	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1430	38.023	21.593	33.273	2.869	4.222	1.833	101.814	1430	2.987	1.999	2.186	0.191	0.494	0.154	8.013
1440	37.849	22.581	32.639	2.876	4.125	1.907	101.977	1440	2.958	2.080	2.133	0.190	0.481	0.160	8.002
1450	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1450	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
1140	0.715	0.059	0.179	0.048	1.000	0.200
1150	0.715	0.058	0.174	0.052	1.000	0.196
1160	0.711	0.063	0.179	0.047	1.000	0.201
1170	0.721	0.067	0.155	0.057	1.000	0.177
1180	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1190	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1200	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1210	0.715	0.074	0.165	0.046	1.000	0.187
1220	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1230	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1240	0.721	0.057	0.173	0.049	1.000	0.194
1250	0.725	0.065	0.160	0.050	1.000	0.181
1260	0.713	0.064	0.168	0.055	1.000	0.190
1270	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1280	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1290	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1300	0.721	0.072	0.154	0.052	1.000	0.176
1310	0.720	0.065	0.163	0.052	1.000	0.185
1320	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1330	0.715	0.065	0.173	0.046	1.000	0.195
1340	0.707	0.063	0.177	0.054	1.000	0.200
1350	0.717	0.057	0.173	0.053	1.000	0.194
1360	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1370	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1380	0.723	0.057	0.165	0.055	1.000	0.186
1390	0.720	0.062	0.171	0.047	1.000	0.192
1400	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1410	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1420	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1430	0.722	0.063	0.163	0.051	1.000	0.184
1440	0.720	0.064	0.162	0.054	1.000	0.184
1450	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
1460	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1460	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1470	37.206	21.562	33.195	2.405	3.917	1.951	100.235	1470	2.971	2.029	2.217	0.163	0.466	0.167	8.014
1480	38.019	22.181	32.776	3.114	4.204	1.977	102.271	1480	2.969	2.041	2.140	0.206	0.489	0.165	8.011
1490	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1490	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1500	37.737	22.060	33.743	2.986	4.022	1.934	102.482	1500	2.954	2.035	2.209	0.198	0.469	0.162	8.028
1510	38.789	21.417	33.092	2.967	4.128	1.945	102.339	1510	3.025	1.969	2.158	0.196	0.480	0.162	7.991
1520	38.018	22.049	33.574	2.685	4.236	1.891	102.453	1520	2.968	2.029	2.192	0.178	0.493	0.158	8.018
1530	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1530	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1540	38.735	21.556	32.347	3.131	4.248	2.124	102.141	1540	3.020	1.981	2.109	0.207	0.494	0.177	7.989
1550	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1550	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1560	37.984	21.592	32.308	2.842	4.001	1.954	100.683	1560	3.006	2.014	2.138	0.191	0.472	0.166	7.987
1570	37.250	21.558	33.319	2.874	3.850	1.824	100.676	1570	2.968	2.024	2.220	0.194	0.457	0.156	8.020
1580	37.997	21.830	32.157	2.874	4.178	1.920	100.956	1580	2.996	2.029	2.120	0.192	0.491	0.162	7.990
1590	38.373	21.984	32.222	2.736	3.959	2.021	101.295	1590	3.011	2.033	2.114	0.182	0.463	0.170	7.973
1600	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1600	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1610	38.702	21.898	32.458	2.729	4.410	2.088	102.285	1610	3.008	2.006	2.110	0.180	0.511	0.174	7.989
1620	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1620	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1630	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1630	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1640	37.091	22.171	33.399	2.964	4.515	1.976	102.116	1640	2.915	2.054	2.196	0.197	0.529	0.166	8.058
1650	38.306	21.891	32.341	3.102	4.273	2.189	102.102	1650	2.991	2.014	2.112	0.205	0.497	0.183	8.002
1660	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1660	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1670	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1670	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1680	38.124	21.475	31.563	2.990	4.089	2.149	100.390	1680	3.019	2.004	2.090	0.201	0.483	0.182	7.979
1690	37.042	22.437	32.704	2.969	4.227	1.992	101.371	1690	2.923	2.087	2.159	0.198	0.497	0.168	8.033
1700	37.851	21.960	33.135	2.914	4.228	1.723	101.811	1700	2.972	2.032	2.176	0.194	0.495	0.145	8.012
1710	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1710	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1720	37.227	21.819	31.515	2.870	3.876	1.956	99.265	1720	2.984	2.061	2.113	0.195	0.463	0.168	7.985
1730	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1730	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1740	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1740	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1750	37.749	21.889	33.207	3.122	4.166	1.960	102.094	1750	2.962	2.024	2.179	0.208	0.487	0.165	8.026
1760	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1760	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1770	37.615	21.929	33.352	2.762	4.417	1.977	102.053	1770	2.951	2.028	2.189	0.184	0.517	0.166	8.035

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
1460	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1470	0.736	0.054	0.155	0.055	1.000	0.174
1480	0.713	0.069	0.163	0.055	1.000	0.186
1490	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1500	0.727	0.065	0.154	0.053	1.000	0.175
1510	0.720	0.065	0.160	0.054	1.000	0.182
1520	0.726	0.059	0.163	0.052	1.000	0.184
1530	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1540	0.706	0.069	0.165	0.059	1.000	0.190
1550	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1560	0.721	0.064	0.159	0.056	1.000	0.181
1570	0.733	0.064	0.151	0.051	1.000	0.171
1580	0.715	0.065	0.166	0.055	1.000	0.188
1590	0.722	0.062	0.158	0.058	1.000	0.180
1600	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1610	0.709	0.060	0.172	0.058	1.000	0.195
1620	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1630	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1640	0.711	0.064	0.171	0.054	1.000	0.194
1650	0.705	0.068	0.166	0.061	1.000	0.191
1660	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1670	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1680	0.707	0.068	0.163	0.062	1.000	0.188
1690	0.714	0.066	0.165	0.056	1.000	0.187
1700	0.723	0.064	0.164	0.048	1.000	0.185
1710	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1720	0.719	0.066	0.158	0.057	1.000	0.180
1730	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1740	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1750	0.717	0.068	0.160	0.054	1.000	0.183
1760	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1770	0.716	0.060	0.169	0.054	1.000	0.191

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
1780	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1780	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1790	37.475	21.993	32.255	2.781	3.743	1.983	100.229	1790	2.981	2.062	2.146	0.187	0.444	0.169	7.988
1800	38.190	22.007	32.552	2.962	4.129	1.946	101.786	1800	2.990	2.031	2.132	0.196	0.482	0.163	7.994
1810	37.284	22.223	32.564	2.737	4.229	2.201	101.238	1810	2.942	2.067	2.149	0.183	0.498	0.186	8.024
1820	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1820	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1830	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1830	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1840	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1840	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1850	37.878	22.548	31.653	3.105	4.218	1.815	101.217	1850	2.972	2.085	2.077	0.206	0.493	0.153	7.986
1860	38.164	22.537	32.552	3.106	3.966	2.016	102.342	1860	2.972	2.068	2.120	0.205	0.460	0.168	7.994
1870	38.397	22.258	32.225	3.093	4.057	2.011	102.041	1870	2.994	2.045	2.101	0.204	0.472	0.168	7.984
1880	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1880	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1890	37.466	21.368	33.488	2.846	4.295	1.959	101.421	1890	2.965	1.993	2.216	0.191	0.507	0.166	8.038
1900	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1900	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1910	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1910	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1920	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1920	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1930	38.233	22.273	32.568	2.797	3.863	2.059	101.795	1930	2.991	2.053	2.130	0.185	0.451	0.173	7.983
1940	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1940	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1950	37.760	21.847	32.170	2.781	3.617	1.977	100.152	1950	3.002	2.047	2.139	0.187	0.429	0.168	7.974
1960	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1960	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1970	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1970	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1980	38.851	22.624	31.778	2.595	4.302	2.116	102.267	1980	3.005	2.062	2.056	0.170	0.496	0.175	7.964
1990	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1990	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2000	38.147	22.540	32.371	2.650	3.758	1.806	101.273	2000	2.992	2.084	2.123	0.176	0.439	0.152	7.966
2010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2020	38.423	22.767	32.651	2.295	4.188	1.845	102.169	2020	2.983	2.083	2.120	0.151	0.485	0.154	7.975
2030	38.149	22.162	32.841	2.703	4.082	1.746	101.685	2030	2.988	2.046	2.151	0.179	0.477	0.147	7.989
2040	37.637	22.241	32.757	2.504	3.959	1.999	101.096	2040	2.968	2.067	2.161	0.167	0.465	0.169	7.998
2050	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2050	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2060	37.968	22.162	33.080	2.359	4.072	1.959	101.600	2060	2.979	2.049	2.171	0.157	0.476	0.165	7.996
2070	38.042	22.550	32.062	3.041	4.251	2.000	101.945	2070	2.968	2.073	2.092	0.201	0.494	0.167	7.996
2080	37.666	22.161	33.143	2.861	4.340	1.828	101.998	2080	2.953	2.047	2.173	0.190	0.507	0.154	8.024
2090	38.497	21.203	32.712	2.676	4.424	2.158	101.671	2090	3.019	1.960	2.146	0.178	0.517	0.181	8.001

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
1780	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1790	0.728	0.064	0.151	0.057	1.000	0.171
1800	0.717	0.066	0.162	0.055	1.000	0.184
1810	0.713	0.061	0.165	0.062	1.000	0.188
1820	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1830	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1840	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1850	0.709	0.070	0.168	0.052	1.000	0.192
1860	0.718	0.069	0.156	0.057	1.000	0.178
1870	0.713	0.069	0.160	0.057	1.000	0.183
1880	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1890	0.720	0.062	0.165	0.054	1.000	0.186
1900	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1910	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1920	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1930	0.725	0.063	0.153	0.059	1.000	0.175
1940	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1950	0.732	0.064	0.147	0.058	1.000	0.167
1960	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1970	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1980	0.710	0.059	0.171	0.061	1.000	0.194
1990	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2000	0.735	0.061	0.152	0.053	1.000	0.171
2010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2020	0.729	0.052	0.167	0.053	1.000	0.186
2030	0.728	0.061	0.161	0.050	1.000	0.181
2040	0.729	0.056	0.157	0.057	1.000	0.177
2050	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2060	0.731	0.053	0.160	0.055	1.000	0.180
2070	0.708	0.068	0.167	0.057	1.000	0.191
2080	0.719	0.063	0.168	0.051	1.000	0.189
2090	0.710	0.059	0.171	0.060	1.000	0.194

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
2100	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2100	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2110	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2110	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2120	38.025	21.559	33.237	2.861	4.488	2.043	102.213	2120	2.977	1.989	2.176	0.190	0.524	0.171	8.028
2130	38.022	22.097	32.797	2.469	3.675	2.167	101.226	2130	2.993	2.050	2.159	0.165	0.431	0.183	7.982
2140	38.024	22.604	32.531	2.830	4.586	1.622	102.198	2140	2.959	2.073	2.117	0.187	0.532	0.135	8.004
2150	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2150	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2160	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2160	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2170	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2170	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2180	38.898	21.631	32.027	2.638	4.258	1.821	101.273	2180	3.044	1.995	2.096	0.175	0.497	0.153	7.959
2190	38.582	21.521	32.643	2.932	4.381	1.679	101.739	2190	3.020	1.985	2.137	0.194	0.511	0.141	7.988
2200	37.851	22.533	33.067	2.636	4.154	1.892	102.133	2200	2.956	2.074	2.160	0.174	0.484	0.158	8.007
2210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2220	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2220	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2230	38.748	21.655	32.808	2.492	4.336	1.669	101.708	2230	3.028	1.994	2.144	0.165	0.505	0.140	7.975
2240	38.527	22.108	33.230	2.310	3.984	1.861	102.020	2240	3.006	2.033	2.168	0.153	0.463	0.156	7.978
2250	37.693	22.627	33.058	2.616	4.090	1.951	102.036	2250	2.948	2.086	2.162	0.173	0.477	0.163	8.009
2260	39.126	22.038	31.900	2.832	4.268	1.849	102.012	2260	3.036	2.016	2.070	0.186	0.494	0.154	7.956
2270	37.811	21.694	33.733	2.622	4.076	1.954	101.890	2270	2.974	2.011	2.219	0.175	0.478	0.165	8.021
2280	37.122	22.614	33.386	2.426	3.868	2.023	101.439	2280	2.928	2.102	2.202	0.162	0.455	0.171	8.021
2290	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2290	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2300	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2300	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2310	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2310	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2320	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2320	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2330	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2330	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2340	37.503	22.286	32.789	2.362	4.314	1.862	101.116	2340	2.956	2.070	2.161	0.158	0.507	0.157	8.009
2350	37.185	22.796	33.041	2.336	4.309	1.536	101.203	2350	2.929	2.116	2.177	0.156	0.506	0.130	8.013
2360	39.108	21.624	32.943	2.540	4.104	1.772	102.092	2360	3.044	1.984	2.145	0.167	0.476	0.148	7.964
2370	37.940	21.735	33.599	2.328	4.382	1.776	101.760	2370	2.979	2.012	2.207	0.155	0.513	0.149	8.015
2380	38.079	21.134	33.139	2.489	4.805	1.722	101.368	2380	2.999	1.962	2.183	0.166	0.564	0.145	8.020
2390	37.755	22.062	33.090	2.462	3.987	1.792	101.148	2390	2.978	2.051	2.183	0.164	0.469	0.151	7.997
2400	38.584	21.827	32.893	2.536	4.269	1.837	101.946	2400	3.012	2.008	2.147	0.168	0.497	0.154	7.985
2410	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2410	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
2100	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2110	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2120	0.711	0.062	0.171	0.056	1.000	0.194
2130	0.735	0.056	0.147	0.062	1.000	0.166
2140	0.713	0.063	0.179	0.046	1.000	0.201
2150	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2160	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2170	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2180	0.718	0.060	0.170	0.052	1.000	0.192
2190	0.716	0.065	0.171	0.047	1.000	0.193
2200	0.726	0.059	0.162	0.053	1.000	0.183
2210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2220	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2230	0.726	0.056	0.171	0.047	1.000	0.191
2240	0.738	0.052	0.158	0.053	1.000	0.176
2250	0.727	0.058	0.160	0.055	1.000	0.181
2260	0.713	0.064	0.170	0.053	1.000	0.193
2270	0.731	0.058	0.157	0.054	1.000	0.177
2280	0.737	0.054	0.152	0.057	1.000	0.171
2290	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2300	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2310	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2320	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2330	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2340	0.725	0.053	0.170	0.053	1.000	0.190
2350	0.733	0.052	0.170	0.044	1.000	0.189
2360	0.730	0.057	0.162	0.050	1.000	0.182
2370	0.730	0.051	0.170	0.049	1.000	0.189
2380	0.714	0.054	0.184	0.048	1.000	0.205
2390	0.736	0.055	0.158	0.051	1.000	0.177
2400	0.724	0.057	0.168	0.052	1.000	0.188
2410	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
2420	38.049	22.059	33.036	2.751	4.457	1.709	102.060	2420	2.974	2.032	2.160	0.182	0.519	0.143	8.010
2430	37.584	22.294	32.321	2.574	4.180	1.649	100.602	2430	2.971	2.077	2.137	0.172	0.493	0.140	7.990
2440	37.207	22.297	32.686	2.891	4.586	2.189	101.855	2440	2.922	2.064	2.147	0.192	0.537	0.184	8.046
2450	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2450	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2460	38.513	22.030	33.095	2.663	4.289	1.830	102.419	2460	2.996	2.020	2.153	0.175	0.497	0.153	7.994
2470	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2470	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2480	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2480	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2490	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2490	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2500	37.290	21.957	32.420	2.585	3.934	1.860	100.046	2500	2.972	2.063	2.161	0.174	0.467	0.159	7.997
2510	37.523	22.122	33.236	2.585	4.069	1.836	101.372	2510	2.959	2.056	2.192	0.173	0.478	0.155	8.013
2520	37.817	22.929	33.032	2.492	3.693	1.723	101.686	2520	2.961	2.116	2.163	0.165	0.431	0.145	7.981
2530	37.717	22.177	33.695	2.483	4.250	1.522	101.843	2530	2.960	2.051	2.212	0.165	0.497	0.128	8.014
2540	36.987	22.910	33.698	2.293	4.005	1.874	101.767	2540	2.909	2.124	2.216	0.153	0.470	0.158	8.029
2550	38.620	22.199	32.895	2.518	4.434	1.770	102.437	2550	2.997	2.030	2.135	0.166	0.513	0.147	7.988
2560	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2560	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2570	37.470	22.474	33.518	2.456	4.176	1.752	101.846	2570	2.941	2.079	2.200	0.163	0.489	0.147	8.019
2580	37.488	22.832	32.502	2.239	4.626	1.767	101.454	2580	2.936	2.108	2.129	0.149	0.540	0.148	8.010
2590	38.259	21.891	33.366	2.182	4.504	1.729	101.931	2590	2.990	2.016	2.181	0.144	0.525	0.145	8.002
2600	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2600	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2610	38.277	22.399	32.537	2.156	4.648	1.765	101.782	2610	2.982	2.057	2.120	0.142	0.540	0.147	7.989
2620	38.285	21.725	32.890	2.371	4.027	1.704	101.001	2620	3.016	2.017	2.167	0.158	0.473	0.144	7.975
2630	36.518	21.503	33.411	2.138	3.834	1.667	99.071	2630	2.955	2.051	2.261	0.147	0.462	0.145	8.020
2640	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2640	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2650	37.927	22.234	33.762	2.177	4.423	1.765	102.289	2650	2.961	2.046	2.204	0.144	0.515	0.148	8.017
2660	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2660	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2670	38.444	22.720	32.697	2.424	4.205	1.870	102.359	2670	2.982	2.077	2.121	0.159	0.486	0.155	7.980
2680	37.094	22.937	34.042	2.339	3.757	1.775	101.944	2680	2.915	2.124	2.237	0.156	0.440	0.150	8.023
2690	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2690	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2700	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2700	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2710	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2710	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2720	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2720	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
2420	0.719	0.061	0.173	0.048	1.000	0.194
2430	0.726	0.059	0.167	0.047	1.000	0.187
2440	0.702	0.063	0.175	0.060	1.000	0.200
2450	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2460	0.723	0.059	0.167	0.051	1.000	0.188
2470	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2480	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2490	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2500	0.730	0.059	0.158	0.054	1.000	0.178
2510	0.731	0.058	0.160	0.052	1.000	0.179
2520	0.745	0.057	0.148	0.050	1.000	0.166
2530	0.737	0.055	0.166	0.043	1.000	0.184
2540	0.740	0.051	0.157	0.053	1.000	0.175
2550	0.721	0.056	0.173	0.050	1.000	0.194
2560	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2570	0.734	0.054	0.163	0.049	1.000	0.182
2580	0.718	0.050	0.182	0.050	1.000	0.202
2590	0.728	0.048	0.175	0.048	1.000	0.194
2600	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2610	0.719	0.048	0.183	0.050	1.000	0.203
2620	0.737	0.054	0.161	0.049	1.000	0.179
2630	0.750	0.049	0.153	0.048	1.000	0.170
2640	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2650	0.732	0.048	0.171	0.049	1.000	0.189
2660	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2670	0.726	0.055	0.166	0.053	1.000	0.186
2680	0.750	0.052	0.148	0.050	1.000	0.164
2690	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2700	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2710	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2720	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
2730	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2730	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2740	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2740	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2750	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2750	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2760	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2760	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2770	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2770	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2780	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2780	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2790	38.135	22.277	33.427	2.100	4.555	1.799	102.293	2790	2.970	2.044	2.177	0.139	0.529	0.150	8.008
2800	38.256	21.058	33.984	1.758	5.060	1.846	101.962	2800	2.997	1.944	2.227	0.117	0.591	0.155	8.031
2810	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2810	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2820	37.699	22.143	33.018	2.087	4.130	1.506	100.583	2820	2.982	2.064	2.184	0.140	0.487	0.128	7.986
2830	37.081	22.286	33.539	2.146	4.454	1.584	101.091	2830	2.932	2.077	2.218	0.144	0.525	0.134	8.030
2840	38.206	22.234	33.126	2.238	4.037	1.760	101.600	2840	2.992	2.052	2.170	0.148	0.471	0.148	7.982
2850	37.519	22.618	33.170	1.789	4.375	1.879	101.350	2850	2.946	2.093	2.178	0.119	0.512	0.158	8.007
2860	38.369	22.113	33.328	1.684	4.428	1.649	101.570	2860	3.000	2.037	2.179	0.111	0.516	0.138	7.982
2870	38.203	22.093	33.604	2.462	4.181	1.743	102.286	2870	2.982	2.032	2.193	0.163	0.487	0.146	8.002
2880	37.873	22.417	33.655	2.101	4.506	1.565	102.117	2880	2.957	2.063	2.198	0.139	0.524	0.131	8.012
2890	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2890	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2900	37.661	21.302	33.756	2.231	3.940	1.748	100.637	2900	2.996	1.997	2.246	0.150	0.467	0.149	8.005
2910	37.970	22.666	33.169	1.678	4.136	1.852	101.471	2910	2.972	2.091	2.171	0.111	0.483	0.155	7.983
2920	37.117	22.101	33.858	2.009	4.721	1.704	101.510	2920	2.927	2.054	2.233	0.134	0.555	0.144	8.046
2930	38.027	21.973	33.116	1.845	4.106	1.907	100.973	2930	2.996	2.040	2.182	0.123	0.482	0.161	7.984
2940	38.119	21.915	32.923	2.005	3.746	1.659	100.367	2940	3.018	2.045	2.180	0.134	0.442	0.141	7.960
2950	39.200	22.008	32.786	2.546	3.965	1.876	102.381	2950	3.039	2.011	2.125	0.167	0.458	0.156	7.956
2960	38.306	21.553	34.033	2.039	4.435	1.487	101.853	2960	3.002	1.991	2.231	0.135	0.518	0.125	8.002
2970	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2970	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2980	37.899	21.838	33.409	2.366	3.975	1.633	101.120	2980	2.992	2.032	2.205	0.158	0.468	0.138	7.993
2990	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2990	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
3000	38.102	22.262	33.278	2.309	3.815	1.559	101.324	3000	2.994	2.062	2.187	0.154	0.447	0.131	7.975
3010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	3010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
3020	36.871	22.171	33.125	2.533	3.678	1.593	99.970	3020	2.950	2.091	2.217	0.172	0.439	0.137	8.004
3030	37.288	21.850	33.375	2.971	3.109	1.833	100.426	3030	2.978	2.057	2.230	0.201	0.370	0.157	7.993

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
2730	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2740	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2750	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2760	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2770	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2780	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2790	0.727	0.046	0.177	0.050	1.000	0.195
2800	0.721	0.038	0.191	0.050	1.000	0.210
2810	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2820	0.743	0.048	0.166	0.043	1.000	0.182
2830	0.734	0.048	0.174	0.044	1.000	0.191
2840	0.739	0.051	0.160	0.050	1.000	0.178
2850	0.734	0.040	0.173	0.053	1.000	0.190
2860	0.740	0.038	0.175	0.047	1.000	0.191
2870	0.734	0.054	0.163	0.049	1.000	0.182
2880	0.735	0.046	0.175	0.044	1.000	0.193
2890	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2900	0.746	0.050	0.155	0.049	1.000	0.172
2910	0.743	0.038	0.165	0.053	1.000	0.182
2920	0.728	0.044	0.181	0.047	1.000	0.199
2930	0.740	0.042	0.164	0.055	1.000	0.181
2940	0.752	0.046	0.153	0.049	1.000	0.169
2950	0.731	0.058	0.158	0.054	1.000	0.177
2960	0.741	0.045	0.172	0.041	1.000	0.188
2970	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2980	0.743	0.053	0.158	0.047	1.000	0.175
2990	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
3000	0.749	0.053	0.153	0.045	1.000	0.170
3010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
3020	0.748	0.058	0.148	0.046	1.000	0.165
3030	0.754	0.068	0.125	0.053	1.000	0.142

TABLE 3D GARNET MAJOR ELEMENT ZONING PROFILES.

191-17b

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total
0	37.665	21.924	31.899	3.593	3.296	1.909	100.286
5	36.914	21.382	31.970	3.695	3.324	1.966	99.251
10	37.512	21.734	32.462	3.537	3.663	1.563	100.471
15	37.079	21.946	32.358	3.696	3.551	1.312	99.943
20	37.312	21.615	32.323	3.477	3.935	1.279	99.940
25	38.111	21.802	31.780	3.664	3.905	1.387	100.649
30	37.603	21.832	32.723	3.547	4.065	1.313	101.082
35	37.825	21.924	31.761	3.697	3.924	1.329	100.460
40	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
45	37.495	21.728	31.663	3.842	4.190	1.183	100.100
50	37.578	21.637	30.897	4.062	4.167	1.157	99.497
55	37.774	22.143	31.129	4.102	4.034	1.229	100.411
60	37.651	21.968	31.243	4.275	4.225	1.233	100.595
65	37.358	21.980	30.771	4.468	4.114	1.110	99.800
70	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
75	37.299	21.896	30.671	4.352	4.097	1.261	99.576
80	37.270	21.784	30.208	4.640	3.944	1.299	99.144
85	37.605	21.787	30.174	4.926	4.060	1.429	99.981
90	37.540	21.931	30.200	5.069	4.029	1.303	100.072
95	37.871	21.967	30.553	5.006	4.089	1.345	100.830
100	37.408	21.721	30.121	4.927	4.324	1.286	99.789
105	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
110	37.014	21.649	29.768	5.370	4.087	1.378	99.267
115	37.827	22.005	30.048	5.283	4.033	1.331	100.527
120	37.751	21.850	29.470	5.213	3.901	1.366	99.551
125	37.338	21.638	29.381	5.511	4.003	1.251	99.122
130	37.320	22.000	29.715	5.453	3.911	1.372	99.771
135	37.706	21.911	29.910	5.589	3.862	1.414	100.391
140	37.639	22.067	29.433	5.825	4.032	1.449	100.445
145	37.404	21.677	29.321	5.923	4.022	1.390	99.737

TABLE 3D GARNET MAJOR ELEMENT ZONING PROFILES.

191-17b Atomic units

Dist	Si	Al	Fe+2	Mn	Mg	Ca	total
0	2.998	2.057	2.123	0.242	0.391	0.163	7.974
5	2.982	2.036	2.160	0.253	0.400	0.170	8.000
10	2.986	2.039	2.161	0.239	0.435	0.133	7.994
15	2.969	2.071	2.167	0.251	0.424	0.113	7.995
20	2.984	2.037	2.162	0.235	0.469	0.110	7.997
25	3.014	2.032	2.102	0.245	0.460	0.118	7.970
30	2.976	2.036	2.166	0.238	0.480	0.111	8.006
35	2.998	2.048	2.106	0.248	0.464	0.113	7.977
40	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
45	2.987	2.040	2.109	0.259	0.498	0.101	7.993
50	3.003	2.038	2.065	0.275	0.496	0.099	7.977
55	2.991	2.067	2.062	0.275	0.476	0.104	7.975
60	2.982	2.051	2.070	0.287	0.499	0.105	7.993
65	2.980	2.067	2.053	0.302	0.489	0.095	7.986
70	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
75	2.982	2.063	2.051	0.295	0.488	0.108	7.987
80	2.991	2.061	2.028	0.315	0.472	0.112	7.978
85	2.994	2.044	2.009	0.332	0.482	0.122	7.984
90	2.987	2.057	2.010	0.342	0.478	0.111	7.984
95	2.992	2.045	2.019	0.335	0.482	0.114	7.986
100	2.985	2.042	2.010	0.333	0.514	0.110	7.994
105	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
110	2.975	2.051	2.001	0.366	0.490	0.119	8.000
115	2.994	2.053	1.989	0.354	0.476	0.113	7.979
120	3.011	2.054	1.966	0.352	0.464	0.117	7.962
125	2.998	2.047	1.973	0.375	0.479	0.108	7.979
130	2.980	2.070	1.984	0.369	0.465	0.117	7.985
135	2.993	2.050	1.986	0.376	0.457	0.120	7.982
140	2.983	2.061	1.951	0.391	0.476	0.123	7.986
145	2.989	2.042	1.960	0.401	0.479	0.119	7.990

TABLE 3D GARNET MAJOR ELEMENT ZONING PROFILES.

191-17b	Percent garnet end member					
Dist	Alm	Sps	Py	Grs	Total	XMg
0	0.727	0.083	0.134	0.056	1.000	0.156
5	0.724	0.085	0.134	0.057	1.000	0.156
10	0.728	0.080	0.146	0.045	1.000	0.167
15	0.734	0.085	0.143	0.038	1.000	0.164
20	0.726	0.079	0.158	0.037	1.000	0.178
25	0.719	0.084	0.157	0.040	1.000	0.180
30	0.723	0.079	0.160	0.037	1.000	0.181
35	0.719	0.085	0.158	0.039	1.000	0.180
40	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
45	0.711	0.087	0.168	0.034	1.000	0.191
50	0.703	0.094	0.169	0.034	1.000	0.194
55	0.707	0.094	0.163	0.036	1.000	0.188
60	0.699	0.097	0.169	0.035	1.000	0.194
65	0.699	0.103	0.166	0.032	1.000	0.192
70	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
75	0.697	0.100	0.166	0.037	1.000	0.192
80	0.693	0.108	0.161	0.038	1.000	0.189
85	0.682	0.113	0.164	0.041	1.000	0.193
90	0.683	0.116	0.163	0.038	1.000	0.192
95	0.685	0.114	0.163	0.039	1.000	0.193
100	0.677	0.112	0.173	0.037	1.000	0.204
105	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
110	0.673	0.123	0.165	0.040	1.000	0.197
115	0.678	0.121	0.162	0.038	1.000	0.193
120	0.678	0.122	0.160	0.040	1.000	0.191
125	0.672	0.128	0.163	0.037	1.000	0.195
130	0.676	0.126	0.159	0.040	1.000	0.190
135	0.676	0.128	0.156	0.041	1.000	0.187
140	0.663	0.133	0.162	0.042	1.000	0.196
145	0.662	0.135	0.162	0.040	1.000	0.196

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
150	37.209	21.841	28.850	5.912	3.891	1.337	99.040	150	2.989	2.068	1.938	0.402	0.466	0.115	7.977
155	37.239	21.737	29.190	6.127	3.754	1.464	99.511	155	2.986	2.054	1.957	0.416	0.449	0.126	7.987
160	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	160	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
165	37.627	21.807	29.221	6.167	3.802	1.440	100.064	165	2.997	2.047	1.946	0.416	0.451	0.123	7.980
170	37.170	21.612	29.485	5.982	3.812	1.491	99.553	170	2.982	2.044	1.979	0.407	0.456	0.128	7.996
175	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	175	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
180	37.862	21.756	28.688	6.111	3.960	1.430	99.807	180	3.013	2.041	1.909	0.412	0.470	0.122	7.967
185	37.421	21.831	28.588	6.097	3.921	1.318	99.177	185	2.998	2.062	1.916	0.414	0.468	0.113	7.971
190	37.710	21.529	29.047	6.104	3.958	1.354	99.703	190	3.011	2.026	1.940	0.413	0.471	0.116	7.976
195	37.798	21.615	28.948	6.456	3.964	1.427	100.208	195	3.005	2.025	1.925	0.435	0.470	0.122	7.982
200	37.045	21.485	29.281	6.134	3.820	1.410	99.175	200	2.984	2.040	1.973	0.419	0.459	0.122	7.996
205	37.620	21.684	29.131	6.243	3.930	1.384	99.991	205	2.998	2.037	1.942	0.421	0.467	0.118	7.983
210	37.671	21.908	28.747	6.046	3.914	1.419	99.704	210	3.002	2.058	1.916	0.408	0.465	0.121	7.969
215	37.534	21.998	29.590	6.098	3.727	1.477	100.425	215	2.983	2.060	1.967	0.410	0.442	0.126	7.987
220	37.343	21.702	28.874	6.125	3.958	1.512	99.514	220	2.989	2.047	1.933	0.415	0.472	0.130	7.987
225	37.525	21.721	29.025	5.824	3.796	1.435	99.326	225	3.005	2.050	1.944	0.395	0.453	0.123	7.970
230	37.641	21.638	28.827	6.168	4.007	1.515	99.797	230	3.002	2.034	1.923	0.417	0.476	0.130	7.981
235	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	235	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
240	37.143	22.103	28.944	6.284	3.827	1.466	99.768	240	2.968	2.082	1.934	0.425	0.456	0.126	7.991
245	37.546	21.556	28.980	5.871	3.924	1.457	99.335	245	3.007	2.035	1.941	0.398	0.468	0.125	7.975
250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
255	37.250	21.689	29.290	5.818	3.759	1.435	99.240	255	2.992	2.053	1.967	0.396	0.450	0.123	7.982
260	37.740	22.110	29.326	5.808	3.965	1.499	100.448	260	2.989	2.064	1.942	0.390	0.468	0.127	7.979
265	37.339	21.677	29.564	5.724	3.884	1.457	99.645	265	2.989	2.045	1.979	0.388	0.463	0.125	7.989
270	37.264	21.644	29.452	5.484	4.073	1.325	99.242	270	2.990	2.047	1.976	0.373	0.487	0.114	7.987
275	37.545	21.279	29.163	5.740	3.913	1.469	99.110	275	3.016	2.015	1.959	0.391	0.469	0.126	7.976
280	37.483	21.798	29.576	5.347	4.045	1.525	99.776	280	2.990	2.049	1.973	0.361	0.481	0.130	7.985
285	38.142	21.719	29.683	5.229	4.184	1.376	100.333	285	3.018	2.026	1.964	0.350	0.494	0.117	7.969
290	38.365	22.430	30.428	5.456	4.185	1.300	102.164	290	2.988	2.059	1.982	0.360	0.486	0.108	7.983
295	37.277	21.643	29.966	5.168	4.168	1.142	99.365	295	2.988	2.045	2.009	0.351	0.498	0.098	7.989
300	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	300	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
305	37.382	21.796	29.985	4.988	4.038	1.328	99.518	305	2.990	2.054	2.006	0.338	0.481	0.114	7.983

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
150	0.663	0.138	0.159	0.039	1.000	0.194
155	0.664	0.141	0.152	0.043	1.000	0.186
160	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
165	0.663	0.142	0.154	0.042	1.000	0.188
170	0.666	0.137	0.154	0.043	1.000	0.187
175	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
180	0.655	0.141	0.161	0.042	1.000	0.197
185	0.658	0.142	0.161	0.039	1.000	0.196
190	0.660	0.140	0.160	0.039	1.000	0.195
195	0.652	0.147	0.159	0.041	1.000	0.196
200	0.664	0.141	0.154	0.041	1.000	0.189
205	0.659	0.143	0.158	0.040	1.000	0.194
210	0.658	0.140	0.160	0.042	1.000	0.195
215	0.668	0.139	0.150	0.043	1.000	0.183
220	0.655	0.141	0.160	0.044	1.000	0.196
225	0.667	0.136	0.155	0.042	1.000	0.189
230	0.653	0.141	0.162	0.044	1.000	0.199
235	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
240	0.658	0.145	0.155	0.043	1.000	0.191
245	0.662	0.136	0.160	0.043	1.000	0.194
250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
255	0.670	0.135	0.153	0.042	1.000	0.186
260	0.664	0.133	0.160	0.043	1.000	0.194
265	0.670	0.131	0.157	0.042	1.000	0.190
270	0.670	0.126	0.165	0.039	1.000	0.198
275	0.665	0.133	0.159	0.043	1.000	0.193
280	0.670	0.123	0.163	0.044	1.000	0.196
285	0.672	0.120	0.169	0.040	1.000	0.201
290	0.675	0.123	0.165	0.037	1.000	0.197
295	0.680	0.119	0.168	0.033	1.000	0.199
300	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
305	0.682	0.115	0.164	0.039	1.000	0.194

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
310	37.574	21.861	29.946	4.887	3.972	1.333	99.572	310	2.999	2.057	1.999	0.330	0.473	0.114	7.972
315	37.575	22.409	30.251	4.784	4.055	1.375	100.449	315	2.974	2.090	2.002	0.321	0.478	0.117	7.981
320	37.717	21.806	30.387	4.621	4.052	1.419	100.002	320	3.000	2.044	2.021	0.311	0.480	0.121	7.978
325	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	325	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
330	37.331	21.707	30.405	4.669	4.198	1.127	99.436	330	2.989	2.048	2.036	0.317	0.501	0.097	7.987
335	37.528	21.590	30.676	4.718	4.154	1.018	99.683	335	2.999	2.034	2.050	0.319	0.495	0.087	7.984
340	37.459	21.740	31.262	4.626	4.382	1.195	100.663	340	2.972	2.033	2.075	0.311	0.518	0.102	8.011
345	37.921	22.321	30.892	4.517	4.542	1.154	101.348	345	2.975	2.064	2.027	0.300	0.531	0.097	7.993
350	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	350	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
355	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	355	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
360	37.340	21.783	30.878	4.122	4.030	1.135	99.287	360	2.993	2.058	2.070	0.280	0.481	0.097	7.979
365	37.746	21.857	31.563	3.569	4.005	1.166	99.906	365	3.004	2.050	2.101	0.241	0.475	0.099	7.971
370	37.801	21.557	30.450	4.244	4.191	1.194	99.437	370	3.018	2.028	2.033	0.287	0.499	0.102	7.968
375	37.894	21.458	31.879	3.789	4.264	1.242	100.526	375	3.006	2.006	2.115	0.255	0.504	0.106	7.991
380	37.170	21.907	31.278	3.849	3.904	1.269	99.377	380	2.980	2.070	2.097	0.261	0.467	0.109	7.985
385	37.474	21.959	31.987	3.686	3.915	1.215	100.236	385	2.982	2.060	2.129	0.248	0.464	0.104	7.988
390	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	390	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
395	37.635	21.973	32.455	3.380	3.640	1.482	100.564	395	2.988	2.056	2.155	0.227	0.431	0.126	7.984
400	37.297	22.151	32.017	3.828	3.785	1.426	100.505	400	2.965	2.075	2.129	0.258	0.449	0.122	7.997
405	37.034	21.811	31.565	3.501	3.397	1.816	99.124	405	2.983	2.070	2.126	0.239	0.408	0.157	7.982
410	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	410	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

TABLE 3E GARNET MAJOR ELEMENT ZONING PROFILES.

TABLE 3E GARNET MAJOR ELEMENT ZONING PROFILES.

191-22a								191-22a		Atomic units					
Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	total
0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
50	37.632	21.916	33.138	1.215	4.488	1.620	100.009	50	2.958	2.070	2.214	0.099	0.537	0.129	8.007
100	37.273	22.134	33.369	1.472	4.542	1.521	100.310	100	2.988	2.042	2.170	0.113	0.540	0.138	7.991
150	37.711	21.866	32.742	1.689	4.575	1.624	100.206	150	2.984	2.056	2.171	0.110	0.529	0.139	7.989
200	37.592	21.975	32.710	1.643	4.468	1.634	100.023	200	2.992	2.064	2.144	0.122	0.518	0.135	7.976
250	37.753	22.095	32.350	1.818	4.385	1.586	99.987	250	3.003	2.047	2.135	0.127	0.521	0.139	7.973
300	38.289	22.148	32.547	1.915	4.454	1.659	101.011	300	2.974	2.054	2.165	0.148	0.523	0.135	7.999

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
310	0.686	0.113	0.162	0.039	1.000	0.191
315	0.686	0.110	0.164	0.040	1.000	0.193
320	0.689	0.106	0.164	0.041	1.000	0.192
325	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
330	0.690	0.107	0.170	0.033	1.000	0.197
335	0.695	0.108	0.168	0.030	1.000	0.194
340	0.690	0.103	0.172	0.034	1.000	0.200
345	0.686	0.102	0.180	0.033	1.000	0.208
350	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
355	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
360	0.707	0.096	0.164	0.033	1.000	0.189
365	0.720	0.083	0.163	0.034	1.000	0.184
370	0.696	0.098	0.171	0.035	1.000	0.197
375	0.710	0.085	0.169	0.035	1.000	0.193
380	0.715	0.089	0.159	0.037	1.000	0.182
385	0.723	0.084	0.158	0.035	1.000	0.179
390	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
395	0.733	0.077	0.147	0.043	1.000	0.167
400	0.720	0.087	0.152	0.041	1.000	0.174
405	0.726	0.082	0.139	0.053	1.000	0.161
410	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

TABLE 3E GARNET MAJOR ELEMENT ZONING PROFILES.

191-22a	Percent garnet end member					
Dist	Alm	Sps	Py	Grs	Total	XMg
0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
50	0.743	0.033	0.180	0.043	1.000	0.195
100	0.733	0.038	0.182	0.047	1.000	0.199
150	0.736	0.037	0.179	0.047	1.000	0.196
200	0.735	0.042	0.177	0.046	1.000	0.195
250	0.731	0.044	0.178	0.048	1.000	0.196
300	0.729	0.050	0.176	0.045	1.000	0.195

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
350	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	350	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
400	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	400	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
450	37.333	21.882	32.285	2.370	4.335	1.662	99.866	450	2.986	2.043	2.142	0.170	0.513	0.138	7.992
500	37.787	21.937	32.402	2.539	4.357	1.625	100.648	500	2.990	2.054	2.116	0.179	0.500	0.143	7.983
550	38.088	22.204	32.231	2.696	4.276	1.695	101.189	550	2.980	2.050	2.134	0.197	0.502	0.132	7.995
600	37.641	21.967	32.220	2.936	4.254	1.556	100.574	600	2.992	2.039	2.132	0.205	0.487	0.133	7.988
650	37.971	21.960	32.355	3.065	4.147	1.570	101.069	650	2.996	2.049	2.107	0.204	0.484	0.139	7.979
700	37.788	21.921	31.774	3.037	4.096	1.640	100.256	700	2.979	2.070	2.081	0.214	0.508	0.133	7.986
750	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	750	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
800	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	800	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
850	38.043	22.050	32.019	3.518	4.055	1.529	101.214	850	2.976	2.062	2.098	0.242	0.486	0.130	7.993
900	37.309	21.929	31.445	3.578	4.088	1.516	99.865	900	2.972	2.071	2.086	0.245	0.483	0.135	7.993
950	37.532	22.197	31.511	3.656	4.094	1.590	100.580	950	2.974	2.075	2.097	0.239	0.461	0.142	7.988
1000	37.465	22.176	31.580	3.553	3.896	1.665	100.334	1000	2.994	2.039	2.080	0.264	0.472	0.138	7.986
1050	37.670	21.762	31.282	3.923	3.980	1.617	100.233	1050	2.985	2.058	2.073	0.254	0.476	0.140	7.986
1100	37.660	22.027	31.277	3.783	4.032	1.651	100.431	1100	2.975	2.056	2.090	0.254	0.479	0.142	7.996
1150	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1150	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1200	37.756	22.157	31.374	3.881	4.002	1.660	100.830	1200	2.971	2.076	2.050	0.266	0.487	0.139	7.991
1250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1300	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1300	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1350	37.879	21.929	30.787	3.886	4.025	1.965	100.471	1350	2.978	2.050	2.066	0.272	0.478	0.153	7.997
1400	37.569	21.940	31.173	4.054	4.047	1.803	100.586	1400	2.974	2.052	2.094	0.269	0.459	0.152	8.000
1450	36.995	21.657	31.153	3.958	3.833	1.761	99.357	1450	2.977	2.054	2.077	0.265	0.490	0.134	7.996
1500	37.600	22.017	31.362	3.946	4.149	1.577	100.652	1500	2.983	2.053	2.092	0.252	0.480	0.130	7.990
1550	37.377	21.826	31.339	3.732	4.032	1.521	99.827	1550	2.980	2.058	2.089	0.244	0.483	0.139	7.991
1600	37.739	22.113	31.633	3.648	4.099	1.640	100.872	1600	3.004	2.038	2.075	0.250	0.478	0.133	7.977
1650	37.727	21.723	31.165	3.703	4.026	1.558	99.903	1650	2.982	2.063	2.092	0.236	0.483	0.129	7.986
1700	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1700	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1750	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1750	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1800	37.677	21.891	31.727	2.968	4.081	1.620	99.965	1800	2.967	2.052	2.164	0.182	0.516	0.126	8.007
1850	37.419	21.960	32.643	2.710	4.367	1.482	100.580	1850	2.976	2.008	2.205	0.183	0.509	0.140	8.020
1900	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1900	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
350	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
400	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
450	0.723	0.057	0.173	0.046	1.000	0.193
500	0.720	0.061	0.170	0.049	1.000	0.191
550	0.720	0.066	0.169	0.045	1.000	0.191
600	0.721	0.069	0.165	0.045	1.000	0.186
650	0.718	0.070	0.165	0.047	1.000	0.187
700	0.709	0.073	0.173	0.045	1.000	0.196
750	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
800	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
850	0.710	0.082	0.164	0.044	1.000	0.188
900	0.707	0.083	0.164	0.046	1.000	0.188
950	0.714	0.081	0.157	0.048	1.000	0.180
1000	0.704	0.089	0.160	0.047	1.000	0.185
1050	0.704	0.086	0.162	0.048	1.000	0.187
1100	0.705	0.086	0.161	0.048	1.000	0.186
1150	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1200	0.697	0.091	0.166	0.047	1.000	0.192
1250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1300	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1350	0.696	0.092	0.161	0.052	1.000	0.188
1400	0.704	0.091	0.154	0.051	1.000	0.180
1450	0.700	0.089	0.165	0.045	1.000	0.191
1500	0.708	0.085	0.162	0.044	1.000	0.187
1550	0.707	0.083	0.163	0.047	1.000	0.188
1600	0.707	0.085	0.163	0.045	1.000	0.187
1650	0.712	0.080	0.164	0.044	1.000	0.188
1700	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1750	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1800	0.724	0.061	0.173	0.042	1.000	0.193
1850	0.726	0.060	0.168	0.046	1.000	0.187
1900	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
1950	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1950	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2000	37.655	22.061	32.539	2.053	4.437	1.615	100.361	2000	2.974	2.069	2.167	0.107	0.527	0.147	7.991
2050	37.601	22.191	32.753	1.604	4.465	1.731	100.345	2050	2.995	2.036	2.208	0.085	0.524	0.140	7.987
2100	37.680	21.731	33.213	1.260	4.426	1.645	99.954	2100	2.975	2.058	2.229	0.076	0.524	0.135	7.996
2150	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2150	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

TABLE 3F GARNET MAJOR ELEMENT ZONING PROFILES.

TABLE 3F GARNET MAJOR ELEMENT ZONING PROFILES.

191-36								191-36			Atomic units				
Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	total
0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
10	37.361	21.595	33.579	1.413	3.056	2.966	99.969	10	2.991	2.037	2.248	0.096	0.365	0.254	7.991
20	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	20	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
30	37.310	22.051	33.689	1.946	2.794	3.305	101.096	30	2.962	2.064	2.237	0.131	0.331	0.281	8.006
40	37.667	21.765	32.639	2.310	2.719	3.336	100.436	40	2.999	2.043	2.174	0.156	0.323	0.285	7.979
50	37.958	21.586	32.508	2.633	2.611	3.515	100.812	50	3.013	2.020	2.158	0.177	0.309	0.299	7.977
60	37.594	21.651	32.318	2.930	2.503	3.594	100.591	60	2.996	2.034	2.154	0.198	0.297	0.307	7.987
70	37.283	21.654	31.606	3.367	2.474	3.770	100.154	70	2.985	2.044	2.117	0.228	0.295	0.323	7.993
80	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	80	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
90	38.016	21.999	31.423	3.938	2.294	3.760	101.430	90	3.002	2.047	2.075	0.263	0.270	0.318	7.975
100	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	100	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
110	37.516	21.775	31.107	4.530	2.095	3.716	100.739	110	2.992	2.046	2.074	0.306	0.249	0.317	7.985
120	37.222	21.416	30.977	5.036	2.096	3.604	100.351	120	2.988	2.026	2.080	0.342	0.251	0.310	7.998
130	37.009	21.784	30.080	5.401	1.923	3.648	99.844	130	2.980	2.067	2.026	0.368	0.231	0.315	7.986
140	37.183	21.408	29.736	5.653	1.879	4.068	99.927	140	2.994	2.032	2.002	0.386	0.226	0.351	7.990
150	37.441	21.654	29.294	6.245	1.939	3.725	100.298	150	2.999	2.044	1.962	0.424	0.231	0.320	7.979
160	37.772	21.642	29.415	6.322	1.947	3.826	100.924	160	3.006	2.030	1.958	0.426	0.231	0.326	7.978
170	37.616	21.617	29.219	6.303	1.675	4.062	100.492	170	3.008	2.037	1.954	0.427	0.200	0.348	7.974
180	37.424	21.600	28.931	6.435	1.767	4.043	100.200	180	3.001	2.041	1.940	0.437	0.211	0.347	7.978
190	37.581	21.598	29.104	6.436	1.784	4.125	100.627	190	3.002	2.033	1.944	0.435	0.212	0.353	7.981
200	37.512	21.846	29.141	6.465	1.875	4.125	101.362	200	2.975	2.042	1.933	0.434	0.222	0.351	7.980
210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
220	36.981	21.416	28.894	7.400	1.712	3.840	100.243	220	2.980	2.034	1.947	0.505	0.206	0.331	8.003

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
1950	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2000	0.735	0.036	0.179	0.050	1.000	0.196
2050	0.747	0.029	0.177	0.047	1.000	0.192
2100	0.752	0.026	0.177	0.045	1.000	0.190
2150	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

TABLE 3F GARNET MAJOR ELEMENT ZONING PROFILES.

191-36	Percent garnet end member					
Dist	Alm	Sps	Py	Grs	Total	XMg
0	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
10	0.759	0.032	0.123	0.086	1.000	0.140
20	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
30	0.751	0.044	0.111	0.094	1.000	0.129
40	0.740	0.053	0.110	0.097	1.000	0.129
50	0.733	0.060	0.105	0.102	1.000	0.125
60	0.729	0.067	0.101	0.104	1.000	0.121
70	0.714	0.077	0.100	0.109	1.000	0.122
80	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
90	0.709	0.090	0.092	0.109	1.000	0.115
100	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
110	0.704	0.104	0.085	0.108	1.000	0.107
120	0.697	0.115	0.084	0.104	1.000	0.108
130	0.689	0.125	0.079	0.107	1.000	0.102
140	0.675	0.130	0.076	0.118	1.000	0.101
150	0.668	0.144	0.079	0.109	1.000	0.106
160	0.666	0.145	0.079	0.111	1.000	0.106
170	0.667	0.146	0.068	0.119	1.000	0.093
180	0.661	0.149	0.072	0.118	1.000	0.098
190	0.660	0.148	0.072	0.120	1.000	0.098
200	0.658	0.148	0.075	0.119	1.000	0.103
210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
220	0.651	0.169	0.069	0.111	1.000	0.096

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
230	37.047	21.586	28.714	7.061	1.632	3.801	99.841	230	2.989	2.052	1.937	0.482	0.196	0.329	7.985
240	38.383	22.188	27.994	7.832	1.690	3.977	102.064	240	3.014	2.053	1.838	0.521	0.198	0.335	7.959
250	37.263	21.448	28.596	7.757	1.745	3.673	100.482	250	2.992	2.029	1.920	0.527	0.209	0.316	7.994
260	37.728	21.688	27.773	7.855	1.633	4.104	100.782	260	3.008	2.038	1.852	0.530	0.194	0.351	7.973
270	34.814	19.883	27.660	8.082	1.641	3.783	95.863	270	2.958	1.991	1.965	0.582	0.208	0.344	8.047
280	37.478	21.693	28.344	8.310	1.581	3.796	101.201	280	2.989	2.039	1.890	0.561	0.188	0.324	7.992
290	37.173	21.621	27.646	8.132	1.553	3.723	100.456	290	2.996	2.054	1.864	0.555	0.187	0.321	7.977
300	36.847	21.660	27.564	8.635	1.626	3.628	99.960	300	2.974	2.061	1.861	0.590	0.196	0.314	7.995
310	37.237	21.746	27.506	8.490	1.617	3.793	100.388	310	2.987	2.056	1.845	0.577	0.193	0.326	7.985
320	36.913	21.764	27.692	8.322	1.474	3.875	100.041	320	2.976	2.068	1.867	0.568	0.177	0.335	7.990
330	37.536	21.662	27.401	8.481	1.657	3.802	100.539	330	3.003	2.042	1.833	0.575	0.198	0.326	7.976
340	36.938	21.503	27.752	8.594	1.536	3.647	99.971	340	2.983	2.047	1.875	0.588	0.185	0.316	7.993
350	37.356	21.421	27.359	8.859	1.656	3.654	100.305	350	3.002	2.028	1.838	0.603	0.198	0.315	7.984
360	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	360	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
370	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	370	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
380	38.719	22.474	27.248	8.863	1.694	3.803	102.801	380	3.016	2.063	1.775	0.585	0.197	0.317	7.953
390	37.469	21.393	27.349	9.037	1.565	3.780	100.594	390	3.004	2.022	1.834	0.614	0.187	0.325	7.985
400	37.313	21.470	27.351	9.215	1.618	3.807	100.774	400	2.990	2.028	1.833	0.625	0.193	0.327	7.996
410	37.018	21.588	27.084	8.926	1.573	3.888	100.077	410	2.983	2.050	1.825	0.609	0.189	0.336	7.992
420	37.151	21.659	27.215	9.387	1.566	3.790	100.769	420	2.978	2.046	1.824	0.637	0.187	0.325	7.999
430	36.968	21.867	27.523	9.106	1.526	3.768	100.758	430	2.965	2.067	1.846	0.619	0.182	0.324	8.002
440	36.977	21.455	27.092	9.016	1.611	3.854	100.004	440	2.984	2.040	1.828	0.616	0.194	0.333	7.996
450	37.245	21.340	27.126	9.064	1.529	3.522	99.826	450	3.007	2.031	1.832	0.620	0.184	0.305	7.978
460	37.109	22.006	26.889	9.211	1.611	3.712	100.538	460	2.973	2.078	1.801	0.625	0.192	0.319	7.988
470	37.466	21.472	27.303	9.260	1.584	3.555	100.641	470	3.002	2.028	1.830	0.629	0.189	0.305	7.983
480	37.330	21.304	26.982	9.194	1.706	3.492	100.008	480	3.007	2.023	1.818	0.627	0.205	0.301	7.981
490	37.511	21.428	27.792	9.252	1.611	3.480	101.074	490	2.999	2.019	1.858	0.626	0.192	0.298	7.992
500	36.999	21.313	27.253	8.893	1.593	3.471	99.522	500	2.998	2.035	1.847	0.610	0.192	0.301	7.984
510	37.464	21.506	27.097	9.116	1.521	3.729	100.433	510	3.005	2.033	1.818	0.619	0.182	0.320	7.978
520	36.477	20.635	26.633	9.099	1.555	3.485	97.885	520	3.009	2.006	1.837	0.636	0.191	0.308	7.988
530	37.567	21.511	27.146	9.164	1.686	3.448	100.522	530	3.009	2.030	1.818	0.622	0.201	0.296	7.976
540	36.709	21.621	27.436	8.961	1.576	3.551	99.854	540	2.970	2.061	1.856	0.614	0.190	0.308	7.999

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
230	0.658	0.164	0.067	0.112	1.000	0.092
240	0.636	0.180	0.068	0.116	1.000	0.097
250	0.646	0.177	0.070	0.106	1.000	0.098
260	0.633	0.181	0.066	0.120	1.000	0.095
270	0.634	0.188	0.067	0.111	1.000	0.096
280	0.638	0.189	0.063	0.109	1.000	0.090
290	0.637	0.190	0.064	0.110	1.000	0.091
300	0.629	0.199	0.066	0.106	1.000	0.095
310	0.627	0.196	0.066	0.111	1.000	0.095
320	0.633	0.193	0.060	0.114	1.000	0.087
330	0.625	0.196	0.067	0.111	1.000	0.097
340	0.633	0.198	0.062	0.107	1.000	0.090
350	0.622	0.204	0.067	0.106	1.000	0.097
360	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
370	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
380	0.618	0.203	0.068	0.110	1.000	0.100
390	0.620	0.207	0.063	0.110	1.000	0.093
400	0.615	0.210	0.065	0.110	1.000	0.095
410	0.617	0.206	0.064	0.113	1.000	0.094
420	0.613	0.214	0.063	0.109	1.000	0.093
430	0.621	0.208	0.061	0.109	1.000	0.090
440	0.615	0.207	0.065	0.112	1.000	0.096
450	0.623	0.211	0.063	0.104	1.000	0.091
460	0.613	0.213	0.066	0.108	1.000	0.097
470	0.620	0.213	0.064	0.103	1.000	0.094
480	0.616	0.213	0.069	0.102	1.000	0.101
490	0.625	0.211	0.065	0.100	1.000	0.094
500	0.626	0.207	0.065	0.102	1.000	0.094
510	0.618	0.211	0.062	0.109	1.000	0.091
520	0.618	0.214	0.064	0.104	1.000	0.094
530	0.619	0.212	0.069	0.101	1.000	0.100
540	0.625	0.207	0.064	0.104	1.000	0.093

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
550	37.269	21.275	26.818	9.342	1.635	3.627	99.967	550	3.005	2.022	1.809	0.638	0.197	0.313	7.984
560	36.956	21.377	26.740	9.224	1.595	3.807	99.698	560	2.990	2.038	1.809	0.632	0.192	0.330	7.991
570	37.275	21.466	27.110	9.204	1.723	3.648	100.427	570	2.993	2.031	1.821	0.626	0.206	0.314	7.991
580	37.322	21.553	27.235	9.002	1.489	3.694	100.296	580	2.999	2.041	1.830	0.613	0.178	0.318	7.980
590	37.107	21.334	27.291	9.159	1.512	3.752	100.156	590	2.993	2.028	1.841	0.626	0.182	0.324	7.993
600	36.845	21.881	27.700	8.821	1.547	3.735	100.529	600	2.961	2.072	1.862	0.600	0.185	0.322	8.003
610	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	610	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
620	36.852	21.845	27.315	8.607	1.510	3.560	99.689	620	2.977	2.080	1.846	0.589	0.182	0.308	7.982
630	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	630	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
640	37.259	21.493	27.956	7.672	1.532	3.860	99.772	640	3.004	2.043	1.885	0.524	0.184	0.334	7.974
650	37.241	22.106	28.473	8.303	1.680	3.901	101.704	650	2.958	2.069	1.891	0.559	0.199	0.332	8.008
660	37.040	21.629	27.332	8.391	1.596	3.689	99.678	660	2.991	2.058	1.846	0.574	0.192	0.319	7.980
670	37.110	21.600	28.044	7.985	1.579	3.824	100.142	670	2.987	2.049	1.888	0.544	0.190	0.330	7.988
680	37.351	21.704	28.513	8.092	1.792	3.762	101.214	680	2.979	2.040	1.902	0.547	0.213	0.321	8.001
690	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	690	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
700	36.930	21.164	27.691	8.059	1.531	3.360	98.735	700	3.012	2.034	1.889	0.557	0.186	0.294	7.971
710	37.150	21.409	28.042	8.062	1.655	3.677	99.993	710	2.995	2.034	1.891	0.551	0.199	0.318	7.988
720	37.197	21.652	27.727	8.239	1.723	3.729	100.267	720	2.988	2.050	1.862	0.561	0.206	0.321	7.987
730	37.231	21.530	27.851	7.611	1.625	3.719	99.567	730	3.005	2.048	1.880	0.520	0.196	0.322	7.971
740	37.395	21.335	28.380	7.645	1.707	3.758	100.220	740	3.006	2.021	1.908	0.520	0.205	0.324	7.984
750	37.425	21.525	28.294	7.422	1.783	3.687	100.136	750	3.005	2.037	1.900	0.505	0.213	0.317	7.977
760	37.008	21.547	28.772	7.082	1.655	3.642	99.706	760	2.990	2.052	1.944	0.485	0.199	0.315	7.984
770	36.974	21.452	29.164	6.711	1.677	3.663	99.641	770	2.990	2.045	1.973	0.460	0.202	0.317	7.987
780	38.513	22.263	29.471	6.388	1.930	3.742	102.308	780	3.014	2.054	1.929	0.423	0.225	0.314	7.959
790	37.674	21.518	29.772	5.913	1.773	3.513	100.162	790	3.020	2.033	1.996	0.401	0.212	0.302	7.964
800	37.568	21.560	30.331	5.850	2.101	3.922	101.331	800	2.987	2.021	2.017	0.394	0.249	0.334	8.002
810	37.274	21.367	30.629	5.392	1.959	3.929	100.549	810	2.989	2.020	2.054	0.366	0.234	0.338	8.001
820	36.975	21.735	30.492	4.957	2.035	3.856	100.051	820	2.973	2.060	2.050	0.338	0.244	0.332	7.997
830	37.458	21.722	31.581	4.632	2.195	3.739	101.326	830	2.978	2.035	2.100	0.312	0.260	0.319	8.004
840	37.309	21.676	30.788	4.305	2.257	3.560	99.896	840	2.994	2.050	2.067	0.293	0.270	0.306	7.980
850	38.163	22.392	31.313	3.947	2.452	3.862	102.129	850	2.989	2.067	2.051	0.262	0.286	0.324	7.978
860	37.618	21.788	32.058	3.244	2.419	3.323	100.449	860	3.000	2.048	2.138	0.219	0.288	0.284	7.976

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
550	0.612	0.216	0.066	0.106	1.000	0.098
560	0.610	0.213	0.065	0.111	1.000	0.096
570	0.614	0.211	0.070	0.106	1.000	0.102
580	0.623	0.208	0.061	0.108	1.000	0.089
590	0.619	0.210	0.061	0.109	1.000	0.090
600	0.627	0.202	0.062	0.108	1.000	0.091
610	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
620	0.631	0.201	0.062	0.105	1.000	0.090
630	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
640	0.644	0.179	0.063	0.114	1.000	0.089
650	0.635	0.187	0.067	0.111	1.000	0.095
660	0.630	0.196	0.066	0.109	1.000	0.094
670	0.640	0.184	0.064	0.112	1.000	0.091
680	0.638	0.183	0.071	0.108	1.000	0.101
690	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
700	0.646	0.190	0.064	0.100	1.000	0.090
710	0.639	0.186	0.067	0.107	1.000	0.095
720	0.631	0.190	0.070	0.109	1.000	0.100
730	0.644	0.178	0.067	0.110	1.000	0.094
740	0.645	0.176	0.069	0.109	1.000	0.097
750	0.647	0.172	0.073	0.108	1.000	0.101
760	0.661	0.165	0.068	0.107	1.000	0.093
770	0.668	0.156	0.068	0.108	1.000	0.093
780	0.667	0.146	0.078	0.109	1.000	0.105
790	0.686	0.138	0.073	0.104	1.000	0.096
800	0.674	0.132	0.083	0.112	1.000	0.110
810	0.687	0.122	0.078	0.113	1.000	0.102
820	0.692	0.114	0.082	0.112	1.000	0.106
830	0.702	0.104	0.087	0.107	1.000	0.110
840	0.704	0.100	0.092	0.104	1.000	0.116
850	0.702	0.090	0.098	0.111	1.000	0.122
860	0.730	0.075	0.098	0.097	1.000	0.119

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
870	37.168	21.896	32.554	2.955	2.602	3.297	100.472	870	2.970	2.062	2.175	0.200	0.310	0.282	7.999
880	37.621	21.601	32.743	2.506	2.593	3.605	100.669	880	2.996	2.028	2.181	0.169	0.308	0.308	7.990
890	37.242	21.994	33.183	1.918	2.790	3.445	100.572	890	2.968	2.066	2.211	0.129	0.331	0.294	8.000
900	37.876	22.044	33.213	1.779	2.747	3.033	100.693	900	3.003	2.060	2.202	0.119	0.325	0.258	7.967
910	37.588	21.745	34.231	1.602	2.806	2.714	100.687	910	2.993	2.041	2.280	0.108	0.333	0.232	7.986
920	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	920	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

TABLE 3G. GARNET MAJOR ELEMENT ZONING PROFILES. TABLE 3G. GARNET MAJOR ELEMENT ZONING PROFILES.

191-46c								191-46c			Atomic units				
Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	total
0	38.507	22.239	30.239	3.038	5.193	1.446	100.662	0	3.011	2.049	1.977	0.201	0.605	0.121	7.965
10	37.813	22.016	30.776	2.752	5.116	1.520	99.993	10	2.988	2.050	2.034	0.184	0.603	0.129	7.987
20	37.873	22.124	30.424	2.943	5.176	1.538	100.079	20	2.987	2.056	2.007	0.197	0.609	0.130	7.985
30	37.905	21.886	30.778	2.710	5.116	1.461	99.856	30	2.998	2.040	2.036	0.182	0.603	0.124	7.982
40	37.892	22.246	30.916	3.053	5.164	1.498	100.770	40	2.975	2.058	2.030	0.203	0.604	0.126	7.996
50	37.428	21.926	30.462	2.589	5.210	1.541	99.156	50	2.980	2.058	2.029	0.175	0.618	0.132	7.991
60	37.739	21.813	30.119	2.772	5.140	1.527	99.110	60	3.002	2.045	2.003	0.187	0.609	0.130	7.976
70	37.717	22.238	30.320	2.917	5.369	1.479	100.041	70	2.974	2.067	2.000	0.195	0.631	0.125	7.992
80	37.827	21.871	31.194	3.018	5.279	1.398	100.586	80	2.980	2.031	2.055	0.201	0.620	0.118	8.005
90	38.133	22.024	31.065	2.789	5.234	1.514	100.760	90	2.991	2.036	2.038	0.185	0.612	0.127	7.990
100	38.197	21.925	30.801	2.993	5.530	1.504	100.949	100	2.990	2.023	2.016	0.198	0.645	0.126	7.999
110	37.679	21.881	30.162	2.879	5.248	1.435	99.283	110	2.993	2.049	2.004	0.194	0.621	0.122	7.983
120	37.983	21.970	30.666	2.783	5.406	1.435	100.243	120	2.991	2.039	2.019	0.186	0.635	0.121	7.990
130	38.039	21.672	31.134	2.709	5.521	1.532	100.607	130	2.991	2.009	2.048	0.180	0.647	0.129	8.004
140	37.924	21.939	30.608	2.680	5.287	1.298	99.736	140	2.998	2.044	2.024	0.179	0.623	0.110	7.979
150	37.435	22.007	30.088	2.767	5.470	1.384	99.150	150	2.977	2.062	2.001	0.186	0.648	0.118	7.992
160	37.749	22.081	30.704	2.701	5.470	1.421	100.125	160	2.977	2.052	2.025	0.180	0.643	0.120	7.997
170	37.694	21.989	30.456	2.926	5.452	1.470	99.986	170	2.978	2.047	2.012	0.196	0.642	0.124	7.999
180	37.006	21.898	30.667	3.081	5.381	1.441	99.475	180	2.950	2.057	2.044	0.208	0.639	0.123	8.022
190	37.966	21.635	30.520	2.854	5.413	1.502	99.890	190	3.001	2.016	2.018	0.191	0.638	0.127	7.991
200	37.798	21.613	30.511	2.733	5.312	1.306	99.272	200	3.005	2.025	2.028	0.184	0.629	0.111	7.983
210	37.539	21.969	29.997	2.932	5.275	1.431	99.141	210	2.986	2.059	1.995	0.198	0.625	0.122	7.985

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
870	0.733	0.067	0.104	0.095	1.000	0.125
880	0.735	0.057	0.104	0.104	1.000	0.124
890	0.745	0.044	0.112	0.099	1.000	0.130
900	0.758	0.041	0.112	0.089	1.000	0.129
910	0.772	0.037	0.113	0.078	1.000	0.128
920	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

TABLE 3G. GARNET MAJOR ELEMENT ZONING PROFILES.

191-46c	Percent garnet end member					
Dist	Alm	Sps	Py	Grs	Total	XMg
0	0.681	0.069	0.208	0.042	1.000	0.234
10	0.690	0.062	0.204	0.044	1.000	0.229
20	0.682	0.067	0.207	0.044	1.000	0.233
30	0.691	0.062	0.205	0.042	1.000	0.229
40	0.685	0.069	0.204	0.043	1.000	0.229
50	0.687	0.059	0.209	0.045	1.000	0.234
60	0.684	0.064	0.208	0.044	1.000	0.233
70	0.678	0.066	0.214	0.042	1.000	0.240
80	0.686	0.067	0.207	0.039	1.000	0.232
90	0.688	0.063	0.207	0.043	1.000	0.231
100	0.675	0.066	0.216	0.042	1.000	0.242
110	0.681	0.066	0.211	0.042	1.000	0.237
120	0.682	0.063	0.214	0.041	1.000	0.239
130	0.682	0.060	0.215	0.043	1.000	0.240
140	0.689	0.061	0.212	0.037	1.000	0.235
150	0.677	0.063	0.220	0.040	1.000	0.245
160	0.682	0.061	0.217	0.040	1.000	0.241
170	0.676	0.066	0.216	0.042	1.000	0.242
180	0.678	0.069	0.212	0.041	1.000	0.238
190	0.678	0.064	0.214	0.043	1.000	0.240
200	0.687	0.062	0.213	0.038	1.000	0.237
210	0.679	0.067	0.213	0.041	1.000	0.239

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
220	37.601	21.731	30.310	3.001	5.306	1.311	99.260	220	2.992	2.038	2.017	0.202	0.629	0.112	7.990
230	38.193	22.232	30.670	2.864	5.408	1.425	100.793	230	2.989	2.050	2.007	0.190	0.631	0.119	7.986
240	38.330	21.940	30.458	2.888	5.249	1.325	100.192	240	3.014	2.033	2.003	0.192	0.615	0.112	7.969
250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
260	37.829	22.016	30.092	3.074	5.188	1.477	99.677	260	2.993	2.053	1.991	0.206	0.612	0.125	7.980
270	38.100	22.110	30.258	2.640	5.346	1.608	100.061	270	2.998	2.050	1.991	0.176	0.627	0.136	7.977
280	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	280	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
290	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	290	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
300	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	300	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
310	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	310	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
320	37.496	21.711	30.775	2.695	5.147	1.445	99.269	320	2.987	2.039	2.051	0.182	0.611	0.123	7.993
330	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	330	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
340	37.580	21.717	30.960	3.078	5.120	1.449	99.904	340	2.982	2.031	2.054	0.207	0.606	0.123	8.003
350	37.908	22.302	30.592	3.005	5.121	1.456	100.383	350	2.982	2.067	2.012	0.200	0.600	0.123	7.985
360	37.747	21.856	30.640	3.065	5.135	1.443	99.885	360	2.989	2.040	2.029	0.206	0.606	0.122	7.991
370	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	370	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
380	37.626	21.736	30.796	3.212	5.255	1.666	100.290	380	2.975	2.025	2.036	0.215	0.619	0.141	8.012
390	37.715	21.726	30.500	2.940	5.334	1.654	99.869	390	2.986	2.027	2.020	0.197	0.630	0.140	8.000
400	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	400	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
410	37.717	21.835	30.274	3.098	5.332	1.509	99.765	410	2.987	2.038	2.005	0.208	0.629	0.128	7.994
420	37.754	22.018	30.308	3.091	5.120	1.555	99.846	420	2.987	2.053	2.005	0.207	0.604	0.132	7.987
430	37.818	22.257	30.124	3.029	5.198	1.580	100.005	430	2.982	2.068	1.987	0.202	0.611	0.134	7.984
440	37.389	21.681	30.352	3.019	4.895	1.555	98.892	440	2.991	2.044	2.031	0.205	0.584	0.133	7.987
450	37.680	21.970	30.494	3.265	5.288	1.592	100.289	450	2.974	2.043	2.013	0.218	0.622	0.135	8.005
460	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	460	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
470	37.544	21.620	30.689	3.291	5.076	1.561	99.782	470	2.984	2.025	2.040	0.222	0.601	0.133	8.004
480	37.640	21.887	30.531	3.199	4.898	1.468	99.623	480	2.989	2.049	2.028	0.215	0.580	0.125	7.986
490	37.586	21.825	30.618	3.483	4.884	1.561	99.957	490	2.982	2.041	2.031	0.234	0.578	0.133	7.998
500	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	500	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
510	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	510	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
520	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	520	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
530	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	530	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
220	0.681	0.068	0.213	0.038	1.000	0.238
230	0.681	0.064	0.214	0.041	1.000	0.239
240	0.685	0.066	0.211	0.038	1.000	0.235
250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
260	0.679	0.070	0.209	0.043	1.000	0.235
270	0.680	0.060	0.214	0.046	1.000	0.239
280	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
290	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
300	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
310	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
320	0.691	0.061	0.206	0.042	1.000	0.230
330	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
340	0.687	0.069	0.203	0.041	1.000	0.228
350	0.685	0.068	0.205	0.042	1.000	0.230
360	0.685	0.069	0.205	0.041	1.000	0.230
370	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
380	0.676	0.071	0.206	0.047	1.000	0.233
390	0.676	0.066	0.211	0.047	1.000	0.238
400	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
410	0.675	0.070	0.212	0.043	1.000	0.239
420	0.680	0.070	0.205	0.045	1.000	0.231
430	0.677	0.069	0.208	0.046	1.000	0.235
440	0.688	0.069	0.198	0.045	1.000	0.223
450	0.674	0.073	0.208	0.045	1.000	0.236
460	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
470	0.681	0.074	0.201	0.044	1.000	0.228
480	0.688	0.073	0.197	0.042	1.000	0.222
490	0.683	0.079	0.194	0.045	1.000	0.221
500	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
510	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
520	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
530	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
540	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	540	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
550	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	550	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
560	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	560	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
570	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	570	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
580	38.442	22.702	30.400	3.282	5.070	1.485	101.380	580	2.988	2.080	1.976	0.216	0.588	0.124	7.972
590	37.871	21.837	30.498	3.232	5.044	1.467	99.948	590	2.996	2.036	2.018	0.217	0.595	0.124	7.986
600	37.667	21.584	30.642	3.286	4.952	1.512	99.642	600	2.995	2.023	2.038	0.221	0.587	0.129	7.993
610	37.666	21.936	29.902	3.713	5.083	1.419	99.719	610	2.986	2.050	1.983	0.249	0.601	0.121	7.989
620	37.638	21.869	30.201	3.353	5.012	1.578	99.652	620	2.987	2.046	2.005	0.225	0.593	0.134	7.990
630	37.759	21.851	30.277	3.600	4.905	1.390	99.783	630	2.994	2.042	2.008	0.242	0.580	0.118	7.985
640	37.380	22.137	30.550	3.533	4.844	1.489	99.933	640	2.966	2.070	2.027	0.237	0.573	0.127	7.999
650	37.434	21.850	30.148	3.630	4.926	1.541	99.528	650	2.979	2.050	2.007	0.245	0.584	0.131	7.996
660	37.652	21.527	30.459	3.540	4.885	1.380	99.443	660	3.000	2.022	2.030	0.239	0.580	0.118	7.989
670	37.793	21.608	30.116	3.457	5.020	1.484	99.478	670	3.004	2.024	2.002	0.233	0.595	0.126	7.984
680	37.498	21.995	29.965	3.608	5.021	1.466	99.553	680	2.979	2.059	1.991	0.243	0.595	0.125	7.991
690	37.720	22.157	30.525	3.600	4.976	1.283	100.261	690	2.978	2.062	2.016	0.241	0.586	0.109	7.991
700	38.040	21.572	30.271	3.502	4.764	1.466	99.615	700	3.020	2.018	2.010	0.235	0.564	0.125	7.971
710	38.097	21.617	30.404	3.682	4.932	1.483	100.216	710	3.010	2.013	2.009	0.246	0.581	0.126	7.984
720	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	720	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
730	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	730	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
740	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	740	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
750	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	750	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
760	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	760	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
770	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	770	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
780	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	780	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
790	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	790	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
800	37.425	21.756	30.451	3.774	4.834	1.386	99.627	800	2.981	2.042	2.028	0.255	0.574	0.118	7.998
810	37.799	21.657	30.510	3.661	4.712	1.389	99.728	810	3.004	2.028	2.028	0.246	0.558	0.118	7.982
820	37.306	22.225	30.309	3.757	4.925	1.407	99.929	820	2.959	2.078	2.011	0.252	0.582	0.120	8.002
830	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	830	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
840	37.678	21.846	30.020	3.850	4.985	1.427	99.806	840	2.988	2.042	1.991	0.259	0.589	0.121	7.991
850	37.865	22.018	30.179	3.534	4.970	1.430	99.997	850	2.993	2.051	1.995	0.237	0.586	0.121	7.982

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
540	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
550	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
560	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
570	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
580	0.681	0.074	0.202	0.043	1.000	0.229
590	0.683	0.073	0.201	0.042	1.000	0.228
600	0.685	0.074	0.197	0.043	1.000	0.224
610	0.671	0.084	0.203	0.041	1.000	0.233
620	0.678	0.076	0.201	0.045	1.000	0.228
630	0.681	0.082	0.197	0.040	1.000	0.224
640	0.684	0.080	0.193	0.043	1.000	0.220
650	0.676	0.082	0.197	0.044	1.000	0.226
660	0.684	0.081	0.196	0.040	1.000	0.222
670	0.677	0.079	0.201	0.043	1.000	0.229
680	0.674	0.082	0.201	0.042	1.000	0.230
690	0.683	0.082	0.199	0.037	1.000	0.225
700	0.685	0.080	0.192	0.043	1.000	0.219
710	0.678	0.083	0.196	0.042	1.000	0.224
720	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
730	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
740	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
750	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
760	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
770	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
780	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
790	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
800	0.682	0.086	0.193	0.040	1.000	0.221
810	0.687	0.084	0.189	0.040	1.000	0.216
820	0.678	0.085	0.196	0.040	1.000	0.225
830	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
840	0.673	0.087	0.199	0.041	1.000	0.228
850	0.679	0.081	0.199	0.041	1.000	0.227

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
860	37.557	21.940	30.792	3.567	4.969	1.401	100.224	860	2.973	2.047	2.039	0.239	0.586	0.119	8.003
870	37.421	22.134	30.384	3.688	4.878	1.441	99.947	870	2.968	2.069	2.015	0.248	0.577	0.122	7.998
880	37.529	22.082	30.192	3.685	5.251	1.386	100.125	880	2.967	2.058	1.996	0.247	0.619	0.117	8.004
890	37.668	21.840	30.335	3.604	5.016	1.387	99.850	890	2.987	2.041	2.012	0.242	0.593	0.118	7.993
900	37.800	21.971	30.180	3.643	5.127	1.410	100.130	900	2.986	2.045	1.994	0.244	0.604	0.119	7.992
910	37.517	22.027	29.405	3.756	5.041	1.465	99.211	910	2.985	2.065	1.957	0.253	0.598	0.125	7.983
920	37.864	21.988	30.268	3.476	4.948	1.382	99.926	920	2.995	2.050	2.002	0.233	0.583	0.117	7.980
930	37.458	21.900	30.563	3.720	5.005	1.435	100.081	930	2.970	2.047	2.027	0.250	0.592	0.122	8.007
940	37.773	21.908	29.729	3.739	5.051	1.334	99.535	940	2.997	2.048	1.972	0.251	0.597	0.113	7.979
950	37.732	21.887	30.210	3.855	5.179	1.373	100.236	950	2.981	2.038	1.996	0.258	0.610	0.116	8.000
960	37.498	22.042	29.565	3.361	5.125	1.503	99.094	960	2.984	2.067	1.968	0.227	0.608	0.128	7.982
970	37.640	21.904	29.766	3.769	5.121	1.372	99.573	970	2.987	2.049	1.976	0.253	0.606	0.117	7.988
980	37.762	21.811	30.027	3.739	4.913	1.442	99.694	980	2.996	2.040	1.993	0.251	0.581	0.123	7.984
990	37.500	21.918	29.989	3.607	5.071	1.454	99.540	990	2.980	2.053	1.993	0.243	0.601	0.124	7.993
1000	37.636	21.862	30.301	3.562	5.147	1.429	99.936	1000	2.981	2.041	2.007	0.239	0.608	0.121	7.998
1010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1020	37.401	21.871	29.886	3.883	5.229	1.462	99.732	1020	2.970	2.047	1.985	0.261	0.619	0.124	8.006
1030	37.492	21.717	30.109	3.774	5.243	1.517	99.851	1030	2.976	2.031	1.998	0.254	0.620	0.129	8.009
1040	37.975	21.962	29.985	3.695	5.163	1.507	100.287	1040	2.992	2.040	1.976	0.247	0.607	0.127	7.988
1050	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1050	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1060	37.629	21.593	29.884	3.756	4.872	1.424	99.158	1060	3.002	2.031	1.994	0.254	0.580	0.122	7.982
1070	38.306	21.907	29.725	3.870	5.184	1.533	100.524	1070	3.007	2.027	1.952	0.257	0.607	0.129	7.979
1080	37.478	21.879	30.036	3.711	4.845	1.464	99.414	1080	2.985	2.053	2.000	0.250	0.575	0.125	7.989
1090	37.618	21.780	29.910	3.616	5.061	1.295	99.280	1090	2.994	2.043	1.991	0.244	0.601	0.110	7.984
1100	37.934	21.615	30.300	3.859	4.996	1.388	100.092	1100	3.002	2.016	2.005	0.259	0.589	0.118	7.990
1110	37.817	22.306	29.815	3.862	4.979	1.482	100.259	1110	2.980	2.072	1.965	0.258	0.585	0.125	7.984
1120	37.706	21.626	30.173	3.763	4.954	1.484	99.706	1120	2.996	2.025	2.005	0.253	0.587	0.126	7.992
1130	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1130	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1140	37.838	21.773	30.026	3.781	4.783	1.653	99.855	1140	2.999	2.034	1.991	0.254	0.565	0.140	7.984
1150	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1150	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1160	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1160	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1170	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1170	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
860	0.683	0.080	0.197	0.040	1.000	0.223
870	0.680	0.084	0.195	0.041	1.000	0.223
880	0.670	0.083	0.208	0.039	1.000	0.237
890	0.679	0.082	0.200	0.040	1.000	0.228
900	0.673	0.082	0.204	0.040	1.000	0.232
910	0.667	0.086	0.204	0.043	1.000	0.234
920	0.682	0.079	0.199	0.040	1.000	0.226
930	0.678	0.084	0.198	0.041	1.000	0.226
940	0.672	0.086	0.204	0.039	1.000	0.232
950	0.670	0.087	0.205	0.039	1.000	0.234
960	0.671	0.077	0.207	0.044	1.000	0.236
970	0.669	0.086	0.205	0.040	1.000	0.235
980	0.676	0.085	0.197	0.042	1.000	0.226
990	0.673	0.082	0.203	0.042	1.000	0.232
1000	0.675	0.080	0.204	0.041	1.000	0.232
1010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1020	0.664	0.087	0.207	0.042	1.000	0.238
1030	0.666	0.085	0.207	0.043	1.000	0.237
1040	0.668	0.083	0.205	0.043	1.000	0.235
1050	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1060	0.676	0.086	0.197	0.041	1.000	0.225
1070	0.663	0.087	0.206	0.044	1.000	0.237
1080	0.678	0.085	0.195	0.042	1.000	0.223
1090	0.676	0.083	0.204	0.037	1.000	0.232
1100	0.675	0.087	0.198	0.040	1.000	0.227
1110	0.670	0.088	0.199	0.043	1.000	0.229
1120	0.675	0.085	0.198	0.043	1.000	0.226
1130	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1140	0.675	0.086	0.192	0.048	1.000	0.221
1150	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1160	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1170	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
1180	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1180	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1190	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1190	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1200	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1200	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1220	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1220	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1230	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1230	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1240	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1240	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1260	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1260	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1270	37.333	21.945	29.705	3.757	5.003	1.381	99.126	1270	2.978	2.063	1.982	0.254	0.595	0.118	7.990
1280	37.665	21.887	30.517	3.895	4.917	1.424	100.306	1280	2.979	2.041	2.019	0.261	0.580	0.121	8.000
1290	37.841	21.928	30.278	3.751	5.117	1.502	100.418	1290	2.984	2.038	1.997	0.251	0.601	0.127	7.997
1300	37.438	21.941	30.366	3.661	5.217	1.447	100.069	1300	2.966	2.048	2.012	0.246	0.616	0.123	8.010
1310	38.066	21.885	29.905	3.640	5.025	1.488	100.008	1310	3.005	2.036	1.974	0.243	0.591	0.126	7.977
1320	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1320	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1330	37.967	21.851	30.272	3.629	4.909	1.379	100.007	1330	3.002	2.037	2.002	0.243	0.579	0.117	7.979
1340	37.984	21.842	30.290	3.564	5.253	1.371	100.303	1340	2.994	2.029	1.997	0.238	0.617	0.116	7.991
1350	37.752	22.085	30.312	3.598	5.095	1.268	100.111	1350	2.982	2.056	2.003	0.241	0.600	0.107	7.989
1360	37.182	22.016	29.738	3.732	5.074	1.456	99.198	1360	2.966	2.070	1.984	0.252	0.603	0.124	7.999
1370	37.490	21.627	30.232	3.722	4.918	1.448	99.437	1370	2.989	2.032	2.016	0.251	0.584	0.124	7.995
1380	38.356	21.599	30.131	3.841	5.141	1.434	100.503	1380	3.017	2.002	1.982	0.256	0.603	0.121	7.982
1390	38.509	22.175	30.556	3.758	5.092	1.452	101.543	1390	2.999	2.035	1.990	0.248	0.591	0.121	7.984
1400	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1400	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1410	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1410	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1420	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1420	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1430	37.971	22.327	30.497	3.779	5.230	1.496	101.300	1430	2.968	2.057	1.994	0.250	0.609	0.125	8.004
1440	37.613	22.040	30.220	3.584	5.053	1.450	99.960	1440	2.978	2.056	2.001	0.240	0.596	0.123	7.994
1450	37.738	21.736	29.755	3.711	4.959	1.364	99.264	1450	3.003	2.039	1.980	0.250	0.588	0.116	7.977
1460	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1460	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1470	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1470	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1480	37.541	21.775	30.336	3.508	5.180	1.524	99.862	1480	2.978	2.036	2.013	0.236	0.613	0.130	8.004
1490	37.352	21.860	30.322	3.469	4.941	1.461	99.405	1490	2.977	2.053	2.021	0.234	0.587	0.125	7.997

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
1180	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1190	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1200	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1220	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1230	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1240	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1250	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1260	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1270	0.672	0.086	0.202	0.040	1.000	0.231
1280	0.677	0.088	0.195	0.041	1.000	0.223
1290	0.671	0.084	0.202	0.043	1.000	0.232
1300	0.671	0.082	0.206	0.041	1.000	0.234
1310	0.673	0.083	0.201	0.043	1.000	0.230
1320	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1330	0.681	0.083	0.197	0.040	1.000	0.224
1340	0.673	0.080	0.208	0.039	1.000	0.236
1350	0.679	0.082	0.203	0.036	1.000	0.231
1360	0.669	0.085	0.204	0.042	1.000	0.233
1370	0.677	0.084	0.196	0.042	1.000	0.225
1380	0.669	0.086	0.204	0.041	1.000	0.233
1390	0.675	0.084	0.200	0.041	1.000	0.229
1400	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1410	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1420	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1430	0.669	0.084	0.205	0.042	1.000	0.234
1440	0.676	0.081	0.201	0.042	1.000	0.230
1450	0.675	0.085	0.200	0.040	1.000	0.229
1460	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1470	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1480	0.673	0.079	0.205	0.043	1.000	0.233
1490	0.681	0.079	0.198	0.042	1.000	0.225

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
1500	37.501	22.079	29.575	3.559	5.019	1.481	99.214	1500	2.983	2.070	1.968	0.240	0.595	0.126	7.982
1510	37.603	21.850	30.113	3.798	5.285	1.541	100.190	1510	2.973	2.036	1.991	0.254	0.623	0.131	8.009
1520	37.475	21.647	30.100	3.505	5.067	1.327	99.121	1520	2.991	2.036	2.009	0.237	0.603	0.113	7.990
1530	37.724	21.771	29.916	3.551	5.009	1.429	99.400	1530	2.999	2.040	1.989	0.239	0.594	0.122	7.981
1540	37.647	21.778	30.044	3.637	5.026	1.493	99.626	1540	2.990	2.039	1.996	0.245	0.595	0.127	7.991
1550	37.614	21.698	30.165	3.258	4.925	1.409	99.069	1550	3.001	2.040	2.013	0.220	0.586	0.120	7.979
1560	37.571	22.003	29.986	3.641	5.033	1.403	99.637	1560	2.982	2.058	1.990	0.245	0.595	0.119	7.989
1570	37.762	21.963	30.104	3.604	5.274	1.409	100.115	1570	2.982	2.044	1.988	0.241	0.621	0.119	7.996
1580	38.328	22.447	30.601	3.538	5.221	1.485	101.620	1580	2.981	2.057	1.990	0.233	0.605	0.124	7.991
1590	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1590	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1600	37.604	21.919	30.389	3.408	5.111	1.343	99.773	1600	2.982	2.049	2.015	0.229	0.604	0.114	7.994
1610	37.446	21.980	29.797	3.458	5.161	1.437	99.278	1610	2.979	2.061	1.983	0.233	0.612	0.122	7.990
1620	37.492	21.748	30.054	3.500	5.161	1.390	99.345	1620	2.985	2.041	2.001	0.236	0.613	0.119	7.994
1630	37.324	21.659	30.027	3.399	5.213	1.425	99.048	1630	2.981	2.039	2.006	0.230	0.621	0.122	7.999
1640	37.492	21.743	29.972	3.523	5.074	1.414	99.218	1640	2.988	2.043	1.998	0.238	0.603	0.121	7.990
1650	37.273	22.033	30.185	3.442	5.086	1.421	99.440	1650	2.967	2.067	2.009	0.232	0.603	0.121	8.000
1660	37.950	21.797	29.493	3.398	5.007	1.446	99.091	1660	3.016	2.042	1.960	0.229	0.593	0.123	7.963
1670	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1670	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1680	38.020	22.079	29.652	3.675	5.006	1.485	99.918	1680	3.001	2.054	1.957	0.246	0.589	0.126	7.972
1690	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1690	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1700	37.477	21.667	30.336	3.348	5.229	1.494	99.550	1700	2.981	2.031	2.018	0.226	0.620	0.127	8.003
1710	37.507	21.839	30.180	3.397	4.850	1.499	99.272	1710	2.989	2.051	2.011	0.229	0.576	0.128	7.985
1720	37.418	21.546	30.323	3.220	5.126	1.629	99.261	1720	2.986	2.026	2.023	0.218	0.610	0.139	8.001
1730	38.030	21.807	30.143	3.493	5.223	1.504	100.199	1730	2.999	2.027	1.988	0.233	0.614	0.127	7.988
1740	37.936	21.649	30.079	3.456	5.129	1.566	99.815	1740	3.004	2.020	1.992	0.232	0.605	0.133	7.986
1750	38.187	21.529	30.207	3.388	5.184	1.540	100.035	1750	3.016	2.004	1.995	0.227	0.610	0.130	7.982
1760	37.104	22.095	30.162	3.353	5.216	1.454	99.383	1760	2.955	2.074	2.009	0.226	0.619	0.124	8.008
1770	37.701	21.742	30.233	3.160	5.254	1.404	99.495	1770	2.993	2.035	2.008	0.213	0.622	0.119	7.989
1780	37.886	21.580	30.060	3.455	5.027	1.399	99.407	1780	3.011	2.021	1.998	0.233	0.596	0.119	7.978
1790	37.801	21.908	30.223	3.373	5.086	1.570	99.961	1790	2.990	2.042	1.999	0.226	0.600	0.133	7.989
1800	37.527	21.930	30.332	3.335	5.299	1.404	99.826	1800	2.974	2.048	2.010	0.224	0.626	0.119	8.002
1810	37.354	21.747	30.937	3.241	5.281	1.287	99.847	1810	2.968	2.036	2.056	0.218	0.626	0.110	8.014

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
1500	0.672	0.082	0.203	0.043	1.000	0.232
1510	0.664	0.085	0.208	0.044	1.000	0.238
1520	0.678	0.080	0.203	0.038	1.000	0.231
1530	0.676	0.081	0.202	0.041	1.000	0.230
1540	0.674	0.083	0.201	0.043	1.000	0.230
1550	0.685	0.075	0.199	0.041	1.000	0.225
1560	0.675	0.083	0.202	0.040	1.000	0.230
1570	0.670	0.081	0.209	0.040	1.000	0.238
1580	0.674	0.079	0.205	0.042	1.000	0.233
1590	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1600	0.680	0.077	0.204	0.039	1.000	0.231
1610	0.672	0.079	0.207	0.042	1.000	0.236
1620	0.674	0.080	0.206	0.040	1.000	0.234
1630	0.673	0.077	0.208	0.041	1.000	0.236
1640	0.675	0.080	0.204	0.041	1.000	0.232
1650	0.677	0.078	0.203	0.041	1.000	0.231
1660	0.675	0.079	0.204	0.042	1.000	0.232
1670	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1680	0.671	0.084	0.202	0.043	1.000	0.231
1690	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1700	0.675	0.075	0.207	0.043	1.000	0.235
1710	0.683	0.078	0.196	0.043	1.000	0.223
1720	0.677	0.073	0.204	0.047	1.000	0.232
1730	0.671	0.079	0.207	0.043	1.000	0.236
1740	0.672	0.078	0.204	0.045	1.000	0.233
1750	0.673	0.076	0.206	0.044	1.000	0.234
1760	0.674	0.076	0.208	0.042	1.000	0.236
1770	0.678	0.072	0.210	0.040	1.000	0.237
1780	0.678	0.079	0.202	0.040	1.000	0.230
1790	0.676	0.076	0.203	0.045	1.000	0.231
1800	0.675	0.075	0.210	0.040	1.000	0.237
1810	0.683	0.072	0.208	0.036	1.000	0.233

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
1820	37.463	21.675	30.271	3.326	5.193	1.475	99.403	1820	2.983	2.034	2.016	0.224	0.616	0.126	8.000
1830	37.589	21.531	30.802	3.334	4.997	1.419	99.671	1830	2.991	2.019	2.050	0.225	0.593	0.121	7.999
1840	37.850	21.857	30.548	3.013	5.060	1.360	99.689	1840	2.999	2.041	2.024	0.202	0.598	0.115	7.980
1850	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1850	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1860	37.733	22.042	30.590	2.987	5.144	1.529	100.025	1860	2.982	2.053	2.022	0.200	0.606	0.129	7.992
1870	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1870	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1880	37.758	21.861	30.327	2.935	5.020	1.421	99.321	1880	3.000	2.047	2.015	0.198	0.595	0.121	7.976
1890	37.957	21.782	30.331	3.068	5.038	1.569	99.744	1890	3.005	2.032	2.008	0.206	0.595	0.133	7.979
1900	37.809	22.092	30.603	2.938	4.943	1.602	99.987	1900	2.988	2.058	2.023	0.197	0.582	0.136	7.983
1910	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1910	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1920	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1920	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1930	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1930	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1940	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1940	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1950	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1950	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1960	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1960	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1970	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1970	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1980	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1980	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1990	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1990	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2000	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2000	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2020	37.805	21.813	30.442	2.836	5.161	1.431	99.488	2020	2.999	2.040	2.020	0.191	0.610	0.122	7.981
2030	37.611	21.823	30.231	2.930	5.109	1.515	99.219	2030	2.993	2.047	2.012	0.198	0.606	0.129	7.984
2040	37.866	22.002	30.020	2.988	5.163	1.484	99.523	2040	2.998	2.053	1.988	0.200	0.609	0.126	7.975
2050	37.695	21.855	30.065	3.139	5.156	1.343	99.253	2050	2.997	2.048	1.999	0.211	0.611	0.114	7.980
2060	37.482	21.749	30.573	3.174	5.258	1.525	99.761	2060	2.976	2.035	2.030	0.213	0.622	0.130	8.007
2070	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2070	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2080	37.517	21.716	30.112	2.888	5.420	1.491	99.143	2080	2.987	2.038	2.005	0.195	0.643	0.127	7.994
2090	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2090	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2100	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2100	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2110	37.896	21.708	29.686	2.902	5.485	1.453	99.131	2110	3.008	2.031	1.971	0.195	0.649	0.124	7.977
2120	37.711	21.694	30.177	2.750	5.191	1.511	99.034	2120	3.003	2.036	2.010	0.185	0.616	0.129	7.979
2130	37.847	21.713	30.210	2.850	5.329	1.395	99.344	2130	3.004	2.031	2.005	0.192	0.631	0.119	7.981

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
1820	0.676	0.075	0.207	0.042	1.000	0.234
1830	0.686	0.075	0.198	0.040	1.000	0.224
1840	0.689	0.069	0.203	0.039	1.000	0.228
1850	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1860	0.684	0.068	0.205	0.044	1.000	0.231
1870	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1880	0.688	0.067	0.203	0.041	1.000	0.228
1890	0.683	0.070	0.202	0.045	1.000	0.228
1900	0.689	0.067	0.198	0.046	1.000	0.224
1910	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1920	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1930	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1940	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1950	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1960	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1970	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1980	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
1990	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2000	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2010	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2020	0.686	0.065	0.207	0.041	1.000	0.232
2030	0.683	0.067	0.206	0.044	1.000	0.232
2040	0.680	0.069	0.208	0.043	1.000	0.235
2050	0.681	0.072	0.208	0.039	1.000	0.234
2060	0.678	0.071	0.208	0.043	1.000	0.235
2070	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2080	0.675	0.066	0.217	0.043	1.000	0.243
2090	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2100	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2110	0.671	0.066	0.221	0.042	1.000	0.248
2120	0.683	0.063	0.210	0.044	1.000	0.235
2130	0.681	0.065	0.214	0.040	1.000	0.239

Dist	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	Total	Dist	Si	Al	Fe+2	Mn	Mg	Ca	Total
2140	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2140	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2150	37.735	21.564	30.323	3.154	5.272	1.530	99.578	2150	2.996	2.018	2.014	0.212	0.624	0.130	7.995
2160	37.577	21.719	29.995	3.024	5.291	1.483	99.089	2160	2.993	2.039	1.998	0.204	0.628	0.127	7.988
2170	38.141	22.007	30.419	2.654	5.248	1.407	99.876	2170	3.007	2.045	2.006	0.177	0.617	0.119	7.971
2180	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2180	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2190	38.070	21.845	30.680	2.841	5.303	1.337	100.076	2190	3.002	2.030	2.023	0.190	0.623	0.113	7.982
2200	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2200	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2220	37.680	21.630	30.800	2.609	5.212	1.397	99.328	2220	2.998	2.028	2.049	0.176	0.618	0.119	7.988
2230	37.650	21.784	30.680	2.642	5.122	1.506	99.384	2230	2.993	2.041	2.040	0.178	0.607	0.128	7.987
2240	37.615	22.083	30.993	2.890	5.069	1.398	100.047	2240	2.976	2.059	2.050	0.194	0.598	0.119	7.995
2250	37.216	22.009	30.794	2.825	5.084	1.458	99.385	2250	2.965	2.066	2.052	0.191	0.604	0.124	8.002
2260	37.581	21.755	30.736	2.816	5.076	1.509	99.473	2260	2.989	2.039	2.044	0.190	0.602	0.129	7.992
2270	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2270	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2280	37.681	21.608	30.782	3.029	4.732	1.469	99.300	2280	3.004	2.031	2.053	0.205	0.562	0.125	7.980
2290	37.493	21.633	30.643	2.841	5.011	1.425	99.045	2290	2.994	2.036	2.047	0.192	0.597	0.122	7.988
2300	37.355	21.710	31.125	2.884	4.795	1.440	99.310	2300	2.983	2.043	2.079	0.195	0.571	0.123	7.995
2310	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2310	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2320	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2320	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2330	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2330	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2340	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2340	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2350	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2350	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2360	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2360	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Dist	Almandine	Spessartine	Pyrope	Grossular	Total	XMg
2140	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2150	0.676	0.071	0.209	0.044	1.000	0.237
2160	0.676	0.069	0.212	0.043	1.000	0.239
2170	0.687	0.061	0.211	0.041	1.000	0.235
2180	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2190	0.686	0.064	0.211	0.038	1.000	0.236
2200	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2210	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2220	0.692	0.059	0.209	0.040	1.000	0.232
2230	0.691	0.060	0.206	0.043	1.000	0.229
2240	0.693	0.065	0.202	0.040	1.000	0.226
2250	0.691	0.064	0.203	0.042	1.000	0.227
2260	0.690	0.064	0.203	0.043	1.000	0.227
2270	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2280	0.697	0.069	0.191	0.043	1.000	0.215
2290	0.692	0.065	0.202	0.041	1.000	0.226
2300	0.700	0.066	0.192	0.042	1.000	0.215
2310	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2320	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2330	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2340	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2350	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
2360	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

N.D.=No detection, either oxide percent totals were outside the acceptable range defined by Kohn (2014) or an inclusion

Atomic units were calculated using
(Total oxygen units*(Number of oxygens in chemical formula/((Oxide percent/General oxide formula)*number of oxygens in oxide)))
/raito of cation to anion)

Percent Garnet endmember was calculated using (atomic unit of the endmember of interest/All cationic endmembers)
note endmembers should sum to 1.0

TABLE 4A LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	5A_G3_01	5A_G3_02	5A_G3_03	5A_G3_04	5A_G3_05	5A_G3_06	5A_G3_07	5A_G3_08	5A_G3_09
Distance across:	50.19	120.86	187.01	257.87	315.57	382.36	452.89	511.52	591.70
Element:									
Na	41.83	48.86	67.02	66.38	85.34	92.27	133.74	123.42	130.98
Mg	24563.68	26343.66	25701.00	23905.68	22550.49	22492.21	23044.89	23579.36	21905.81
Al	115270.74	113524.21	116805.56	119187.20	112730.33	114053.45	110560.40	119875.20	114582.70
Si^{29}	173932.78	170106.97	179084.77	169731.55	167831.11	169215.38	161758.11	174289.39	170666.59
Si^{30}	173387.14	191332.31	178066.88	176834.36	172611.14	179690.78	174142.88	180692.16	166964.33
P	39.57	71.56	69.56	85.65	61.50	77.54	96.25	BDL	BDL
Ca^{43}	14877.49	14198.72	14707.33	14566.75	14010.05	13821.83	13361.08	13627.04	12910.14
Ca^{44}	13902.22	13824.93	14178.65	13854.56	13091.74	13145.90	12823.69	13370.39	12294.30
Sc	220.42	223.79	187.44	152.27	140.32	132.47	128.39	144.95	118.78
Ti	26.71	47.65	3600.68	106.86	110.99	115.65	108.10	123.26	106.85
Mn	13159.51	14190.97	17062.45	18508.30	19926.64	21735.97	23667.59	25449.93	24960.86
Fe	222089.19	227510.03	224279.84	213070.02	209835.50	207985.36	202678.80	218636.81	211695.47
Y	231.59	307.49	619.47	839.45	1085.21	1348.76	1579.21	1807.54	1594.96
Zr	2.50	3.94	8.47	32.99	10.59	10.12	6.11	5.45	8.32
La	0.01	BDL	BDL	BDL	0.02	0.02	BDL	BDL	BDL
Ce	BDL	BDL	0.04	0.02	0.04	0.03	0.01	BDL	BDL
Pr	BDL	0.01	0.02	0.01	0.02	0.02	BDL	0.01	BDL
Nd	0.27	0.23	0.22	0.20	0.34	0.28	0.23	BDL	BDL
Sm	1.06	1.54	1.96	2.69	2.25	3.57	1.52	1.89	1.17
Eu	0.07	0.16	0.14	0.22	0.24	0.24	0.14	0.11	0.25
Gd	10.79	14.42	25.86	32.87	33.24	39.88	24.03	27.12	23.23
Tb	4.05	5.61	10.85	14.51	14.75	17.51	13.65	14.42	13.25
Dy	36.30	50.68	102.43	133.28	155.32	191.81	194.77	221.57	203.05
Ho	8.38	11.41	20.72	25.37	33.30	43.28	65.04	80.81	77.74
Er	24.28	27.81	48.17	59.72	98.63	117.85	232.74	327.43	349.47
Tm	3.37	3.60	5.53	6.49	12.57	15.03	34.69	50.59	62.70
Yb	24.52	23.94	32.42	34.72	74.75	87.10	222.52	351.16	501.50
Lu	3.90	3.67	3.76	3.64	9.83	11.18	30.99	51.17	82.58
Hf	BDL	0.13	0.19	1.11	0.39	0.39	0.33	0.25	0.46

TABLE 4A LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	5A_G3_10	5A_G3_11	5A_G3_12	5A_G3_13	5A_G3_14	5A_G3_15	5A_G3_16	5A_G3_17	5A_G3_18
Distance across:	674.95	749.88	824.03	900.85	981.52	1062.83	1129.79	1205.62	1275.77
Element:									
Na	170.78	126.93	138.36	128.36	118.16	77.08	59.57	56.97	26.13
Mg	21620.18	23275.67	22798.95	22102.44	24065.79	23166.05	25390.43	25580.63	26382.15
Al	112518.63	118181.59	117176.02	112412.77	116593.85	113788.83	122150.98	120404.45	115588.27
Si^{29}	163804.88	172491.50	178071.91	162176.47	166581.45	175446.55	183787.89	191421.92	168525.41
Si^{30}	182044.38	202449.08	180827.48	171473.02	180928.44	178927.61	206677.72	195300.08	199588.06
P	BDL	73.35	99.07	101.42	77.70	BDL	70.63	102.83	BDL
Ca^{43}	12745.96	13767.39	12867.60	12716.24	13392.88	13540.88	14944.50	14713.73	14346.67
Ca^{44}	12911.44	13251.04	13155.05	12497.49	12811.28	12754.03	13923.30	14811.47	13809.63
Sc	114.08	120.94	131.85	129.26	124.36	141.31	170.47	212.38	220.70
Ti	110.04	97.26	101.07	97.57	110.75	117.75	99.30	87.21	58.54
Mn	25322.44	26083.00	24809.86	23281.50	23116.85	19978.84	19330.74	16300.59	14176.60
Fe	204803.59	213191.67	210404.22	196937.48	212792.14	204775.56	220314.08	223083.44	218720.80
Y	1842.10	1663.68	1744.17	1684.69	1557.94	1056.02	955.06	591.69	317.08
Zr	43.79	8.69	5.09	8.24	6.35	6.85	6.32	13.21	5.96
La	BDL	BDL	0.01	BDL	0.01	BDL	BDL	BDL	BDL
Ce	0.03	0.01	BDL	BDL	0.04	0.02	BDL	BDL	BDL
Pr	0.00	BDL	0.01	BDL	0.01	0.01	BDL	BDL	BDL
Nd	0.27	BDL	BDL	0.13	0.32	0.23	BDL	BDL	BDL
Sm	2.14	2.06	1.31	1.39	1.75	2.65	2.61	2.06	0.62
Eu	0.25	0.18	0.17	0.18	0.13	0.21	0.15	0.16	BDL
Gd	28.35	29.58	27.16	23.42	27.30	31.12	30.36	25.43	13.13
Tb	15.00	15.82	14.06	13.03	14.85	14.10	13.19	10.61	5.62
Dy	226.90	225.49	213.47	203.81	200.45	153.17	140.53	97.81	51.25
Ho	82.67	76.06	81.58	74.14	56.32	36.26	32.88	19.30	11.93
Er	356.94	309.28	371.03	288.19	186.48	102.49	89.17	46.59	30.84
Tm	63.90	53.33	64.47	43.74	25.63	13.85	11.44	5.50	3.51
Yb	479.99	418.60	484.65	294.30	158.03	86.37	68.24	31.08	24.31
Lu	72.27	64.63	78.33	40.20	19.16	12.24	9.41	4.63	4.24
Hf	1.33	0.64	0.29	0.35	0.25	0.32	BDL	0.39	0.32

TABLE 4A LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	5A_G3_19
Distance across:	1317.09
Element:	
Na	38.33
Mg	23696.54
Al	114794.40
Si^{29}	175002.78
Si^{30}	190130.28
P	98.54
Ca^{43}	14838.93
Ca^{44}	13900.65
Sc	231.27
Ti	44.90
Mn	13164.67
Fe	219319.17
Y	253.16
Zr	2.65
La	0.01
Ce	BDL
Pr	BDL
Nd	0.18
Sm	0.85
Eu	0.05
Gd	11.58
Tb	4.27
Dy	40.11
Ho	9.16
Er	26.73
Tm	3.70
Yb	26.83
Lu	4.39
Hf	0.14

One Sigma Error

	5A_G3_01	5A_G3_02	5A_G3_03	5A_G3_04	5A_G3_05	5A_G3_06	5A_G3_07	5A_G3_08	5A_G3_09
Na	4.39	5.54	5.93	7.13	7.38	9.12	8.64	10.47	9.43
Mg	799.64	859.47	840.36	783.65	741.24	741.51	761.89	782.07	728.93
Al	3645.43	3590.31	3693.9	3769.3	3565.18	3607.19	3496.53	3791.18	3623.71
Si^{29}	7571.59	7426.36	7833.96	7449.08	7388.79	7478.89	7167	7752.95	7614.65
Si^{30}	7784.95	8649.45	8099.23	8149.33	7996.13	8462.87	8159.64	8654.78	7981.71
P	14.98	20.95	21.26	26.17	23.92	29.83	28.51	32.15	27.51
Ca^{43}	503.06	498.96	487.61	500.32	493.34	516.9	469.04	497.78	452.37
Ca^{44}	453.73	464.38	475.47	483.71	463.83	495.21	464.82	518.25	467.17
Sc	7.64	7.82	6.56	5.41	5.04	4.86	4.68	5.34	4.4
Ti	1.74	2.77	135.12	4.9	5.27	5.93	5.08	6.04	5.1
Mn	442.89	479.46	578.8	630.65	682.2	747.91	818.58	885.11	873.07
Fe	7175.18	7368.57	7279.86	6935.7	6850.91	6813.29	6658.34	7207.8	7002.46
Y	7.37	9.81	19.69	26.74	34.65	43.18	50.62	58.11	51.4
Zr	0.15	0.23	0.33	1.12	0.45	0.48	0.29	0.29	0.36
La	0.0051	0.0053	0.012	0.011	0.008	0.01	0.013	0.017	0.011
Ce	0.0084	0.0089	0.016	0.0083	0.012	0.014	0.0066	0.019	0.014
Pr	0.0069	0.0067	0.0053	0.0057	0.011	0.011	0.0082	0.0053	0.012
Nd	0.067	0.082	0.077	0.081	0.092	0.12	0.09	0.083	0.089
Sm	0.15	0.21	0.17	0.25	0.25	0.36	0.18	0.23	0.17
Eu	0.018	0.033	0.029	0.035	0.041	0.051	0.034	0.028	0.036
Gd	0.55	0.75	1.02	1.33	1.4	1.76	1.06	1.25	1.03
Tb	0.16	0.22	0.36	0.48	0.5	0.61	0.46	0.5	0.45
Dy	1.33	1.87	3.48	4.56	5.34	6.68	6.68	7.66	7.01
Ho	0.3	0.42	0.69	0.85	1.12	1.47	2.15	2.68	2.57
Er	0.9	1.06	1.66	2.09	3.41	4.13	7.88	11.12	11.86
Tm	0.14	0.16	0.2	0.24	0.44	0.54	1.11	1.62	1.97
Yb	0.92	0.96	1.12	1.25	2.54	3.03	7.09	11.15	15.74
Lu	0.17	0.17	0.15	0.16	0.39	0.46	1.13	1.86	2.96
Hf	0.041	0.04	0.042	0.11	0.089	0.097	0.073	0.08	0.07

One Sigma Error

	5A_G3_10	5A_G3_11	5A_G3_12	5A_G3_13	5A_G3_14	5A_G3_15	5A_G3_16	5A_G3_17	5A_G3_18
Na	10.86	9.72	10.5	9.42	8.38	7.5	7.77	9.99	7.09
Mg	722	780.05	767.03	746.54	816.15	788.82	868.32	878.92	879.56
Al	3558.58	3737.58	3705.91	3555.32	3687.55	3598.61	3863.08	3808.19	3656.06
Si^{29}	7341.11	7756.47	8042.98	7356.93	7587.66	8020.58	8441.46	8843.79	7415.39
Si^{30}	8751.8	9665.4	8801.24	8343.91	8748.11	8684.88	10051.72	9749.09	9419.26
P	28.02	29.62	33.69	31.2	26.06	23.24	25.99	34.7	22.18
Ca^{43}	471.77	487.58	479.92	483.34	503.69	472.63	522.62	573.65	580.52
Ca^{44}	498.93	499.55	509.98	474.78	468.05	461.65	502.79	566.71	492.76
Sc	4.32	4.56	5.03	4.96	4.81	5.41	6.56	8.31	7.51
Ti	5.67	4.97	5.53	5.43	6.08	5.81	5.18	5.43	4.08
Mn	891.08	923.52	884.14	835.21	834.97	726.64	708.14	601.64	496.74
Fe	6801.56	7106.28	7043.28	6620.77	7184.35	6941.75	7503.06	7637.41	6995.42
Y	59.55	53.94	56.75	55	51.05	34.71	31.52	19.69	10.65
Zr	1.52	0.39	0.3	0.42	0.36	0.31	0.31	0.64	0.41
La	0.023	0.012	0.0057	<0.00	0.0089	<0.00	0.0099	0.018	<0.00
Ce	0.012	0.0066	0.016	0.011	0.014	0.0071	0.0091	0.019	0.014
Pr	0.004	0.01	0.0078	0.0082	0.007	0.0061	0.01	0.015	0.0044
Nd	0.11	0.099	0.084	0.08	0.12	0.061	0.089	0.14	0.1
Sm	0.26	0.24	0.21	0.23	0.27	0.25	0.25	0.31	0.19
Eu	0.05	0.037	0.042	0.044	0.042	0.033	0.03	0.044	0.033
Gd	1.32	1.31	1.32	1.2	1.36	1.34	1.34	1.39	0.95
Tb	0.52	0.53	0.5	0.47	0.53	0.47	0.45	0.42	0.28
Dy	7.93	7.87	7.58	7.3	7.23	5.49	5.1	3.81	2.14
Ho	2.76	2.54	2.75	2.52	1.94	1.25	1.15	0.74	0.5
Er	12.23	10.64	12.85	10.1	6.66	3.68	3.25	1.91	1.34
Tm	2.04	1.7	2.07	1.43	0.87	0.47	0.4	0.26	0.2
Yb	15.2	13.25	15.42	9.53	5.3	2.9	2.36	1.37	1.21
Lu	2.64	2.37	2.9	1.53	0.77	0.49	0.39	0.25	0.24
Hf	0.17	0.091	0.07	0.092	0.093	0.069	0.073	0.1	0.11

One Sigma Error

	5A_G3_19
Na	6
Mg	791.89
Al	3630.38
Si^{29}	7702.69
Si^{30}	8946.6
P	24.8
Ca^{43}	503.98
Ca^{44}	474.97
Sc	7.7
Ti	2.26
Mn	463.34
Fe	7020.38
Y	8.44
Zr	0.16
La	0.0043
Ce	0.0076
Pr	0.0055
Nd	0.082
Sm	0.14
Eu	0.022
Gd	0.57
Tb	0.17
Dy	1.47
Ho	0.34
Er	0.98
Tm	0.15
Yb	0.98
Lu	0.18
Hf	0.043

TABLE 4B LA-ICP-MS GARNET ZONATION DATA

Sample Analysis	8AG2_01	8AG2_02	8AG2_03	8AG2_04	8AG2_05	8AG2_06	8AG2_07	8AG2_08	8AG2_09
Distance across:	64.2	119.1	210.72	302.03	391.93	481.83	581.73	697.83	807.53
Element:									
Na	93.43	157.95	186.93	170.96	151.09	178.94	204.86	197.97	168
Mg	19596.75	15273.61	12900.44	11636.76	10529.67	10333.19	9323.26	8522.64	8094.92
Al	113365.41	119504.72	115164.87	115429.49	118181.59	120563.22	116699.7	113471.27	107808.3
Si^{29}	175388.03	180235.73	172143.89	175923.81	172514.27	188194.98	176462.03	171813.09	168375.06
Si^{30}	177347.5	177209.45	185294.42	182022.23	185654.7	197401.13	187944.39	171662.59	167347.66
P	BDL	BDL	45.06	41.87	138.86	BDL	605.83	41.32	BDL
Ca^{43}	28119.89	36357.38	35671.79	37260.22	40862.2	43910.29	43466.09	43739.86	42087.36
Ca^{44}	27830.72	34557.92	34917.21	35713.95	39884.16	42914.04	42531.45	42673.11	41829.16
Sc	273.56	256.57	259.38	260.42	307.52	391.96	408.2	380.89	320.34
Ti	409.51	439.58	468.59	497.54	600.33	684.88	720.5	668.29	689.12
Mn	15734.27	21972.81	26426.02	33456.41	43860.82	53509.54	57455.38	59955.02	60249.84
Fe	211478.45	219838.13	206618.28	201174.66	191873.02	191952.45	190627.84	176048.83	169041.81
Y	377.11	648.13	979.77	970.45	750.1	696.48	583.39	774.46	710.38
Zr	3.95	3.09	2.99	2.76	2.62	2.84	2.76	1.86	2.17
La	0.0091	0.0068	0.0258	0.0016	0.0146	BDL	0.0205	BDL	BDL
Ce	0.0173	BDL	0.0514	BDL	0.0417	0.003	0.077	0.0128	0.0025
Pr	0.0072	0.004	0.0057	0.0051	BDL	BDL	0.0162	0.0024	BDL
Nd	BDL	BDL	BDL	BDL	BDL	BDL	0.099	BDL	BDL
Sm	0.236	0.406	0.369	0.497	0.371	0.317	0.382	0.225	0.183
Eu	0.39	0.66	0.545	0.509	0.457	0.412	0.351	0.245	0.178
Gd	6.45	8.02	7.95	6.65	6.13	5.58	3.83	3.05	2.35
Tb	3.92	5.66	5.87	4.88	4.26	3.74	2.73	2.123	1.699
Dy	55.92	81.9	102.5	91.84	74.02	67.32	51.89	46.95	39.52
Ho	14.55	24.17	35.53	34.95	27.26	24.51	20.18	25.39	22.88
Er	43.06	76.52	128.02	139.11	103.26	95.09	79.97	138.82	146.08
Tm	6.01	10.61	18.7	21.66	15.63	13.73	12.72	27.02	31.58
Yb	36.14	66.49	121.86	147.11	102.09	91.84	86.2	195.84	263.11
Lu	4.62	7.92	14.15	17.63	12.4	11.59	11.89	26.34	39.17
Hf	0.118	0.14	0.143	0.151	0.121	0.092	0.102	0.074	0.098

TABLE 4B LA-ICP-MS GARNET ZONATION DATA

Sample Analysis:	8AG2_10	8AG2_11	8AG2_12	8AG2_13	8AG2_14	8AG2_15	8AG2_16	8AG2_17	8AG2_18
Distance across:	904.93	1011.45	1111.95	1210.85	1309.65	1412.95	1508.75	1603.25	1726.55
Element:									
Na	177.13	201.56	206.06	213.88	190.56	200.36	225.22	242.82	195.83
Mg	8117.98	7781.96	7834.06	8101.59	7981.16	7895.75	8294.12	8774.1	8853.56
Al	113418.34	112359.84	114582.7	117334.8	118234.52	110401.62	110507.45	117493.57	112465.69
Si^{29}	173873.92	174631.67	175404.31	178239.41	169416.23	167615.42	162764.48	182762.97	176919.06
Si^{30}	79995.3	184733.73	197059.14	191676.13	196800.75	184244.55	183310.03	194241.63	189076.7
P	BDL	67.84	BDL	54.72	54.41	BDL	45.94	66.6	46.79
Ca^{43}	45905.82	47452.81	48707.39	49614.09	50096.16	46124.54	44709.62	45575.25	44251.76
Ca^{44}	44352.55	46149.47	47373.4	49024.19	47904.02	45494.22	44709.54	44984.29	43238.18
Sc	326.17	316.46	291.67	299.56	290.72	332.31	337.53	363.28	384.41
Ti	719.31	674.14	630.57	657.66	656.55	703.82	703.87	762.79	747.12
Mn	61529.9	63130.29	63233.03	64636.23	64730.25	61751.48	60691.4	62848.83	57072.95
Fe	170919.58	173340.66	170579.98	174437.36	171508.86	169636.89	173961.98	183284.17	182919.66
Y	645.69	535.99	506.06	515.12	536.99	535.07	710.06	830	592.21
Zr	2.09	1.73	1.48	1.51	1.48	1.95	2.22	2.01	2.71
La	BDL	0.0038	0.0018	0.0105	0.0025	BDL	0.0189	0.0077	0.0082
Ce	0.0087	0.0162	0.0086	0.0117	BDL	0.0184	0.0166	0.019	0.0016
Pr	BDL	0.0015	BDL	BDL	0.0019	BDL	BDL	BDL	0.0052
Nd	BDL	0.07	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sm	0.167	BDL	0.129	BDL	BDL	0.145	0.183	0.295	0.332
Eu	0.163	0.09	0.073	0.082	0.08	0.134	0.206	0.197	0.365
Gd	1.96	1.25	1.11	1.15	1.05	1.55	2.29	2.99	4.34
Tb	1.432	1.039	0.869	0.797	0.844	1.104	1.696	2.354	2.86
Dy	33.14	23.44	22.03	22.02	22.88	26.32	40.83	50.8	51.85
Ho	20.97	16.88	15.66	16.28	16.52	16.85	23.18	27.33	20.35
Er	149.78	149.12	145.89	154.55	154.69	128.77	147.38	148.76	83.2
Tm	38.64	48.09	53.79	57.43	57.69	36.56	32.53	29.07	13.13
Yb	364.85	587.02	762.17	801.83	803.76	385.84	276.69	217.92	90.16
Lu	58.89	111.96	163.76	175.12	174.62	66.95	41.28	29.16	12.5
Hf	0.108	0.057	0.069	0.067	0.12	0.067	0.075	0.109	0.128

TABLE 4B LA-ICP-MS GARNET ZONATION DATA

Sample Analysis	8AG2_19	8AG2_20	8AG3_21	8AG3_22	8AG3_23	8AG3_24	8AG3_25	8AG3_26
Distance across:	1814.82	1933.52	2027.82	2137.42	2237.92	2329.22	2441.92	2505.32
Element:								
Na	202.89	187.63	198.19	178.27	149.03	128.55	122.95	95.65
Mg	9554.87	10368.17	12201.91	12859.43	13623.75	14568.07	17252.16	19386.22
Al	116646.77	111724.74	117493.55	116646.77	116435.05	111618.88	119557.63	114318.07
Si^{29}	174226.39	170334.98	175504.27	172466.78	171009.84	174963.44	185724.38	176051.31
Si^{30}	188024.98	181583.67	192150.19	202831.13	201499.27	186222.56	206283.25	190621.53
P	50.77	45.38	75.85	44.51	77.25	45.83	<45.28	63.02
Ca^{43}	44509.84	40367.58	40802.09	37038.8	36547.11	34978.88	38284.65	33650.08
Ca^{44}	44106.41	38792.17	39281.03	35015.44	35286.63	33904.06	37506.81	32718.93
Sc	399.02	317.48	275.49	247.53	266.06	282.33	278.86	232.48
Ti	738.06	611.01	534	437.98	414.67	365.98	380.94	343.42
Mn	51881.57	43146.33	36023.36	29076.59	22405.08	15124.83	10737.29	10759.08
Fe	189077.84	191243.33	207670.83	218747.38	217347.06	207626.88	228879.45	218152.55
Y	691.17	737.11	1018.39	953.15	691.45	381.41	278.68	185.18
Zr	2.62	2.65	2.76	2.39	2.81	2.6	3	2.59
La	BDL	BDL	BDL	0.0018	0.0107	BDL	0.0026	BDL
Ce	0.0209	0.0088	BDL	BDL	0.0082	0.0057	0.0199	0.0099
Pr	0.0107	BDL	0.0031	0.0029	0.0034	0.0016	0.0061	BDL
Nd	BDL	BDL	0.105	BDL	BDL	0.045	BDL	BDL
Sm	0.423	0.308	0.482	0.458	0.539	0.407	0.465	0.263
Eu	0.371	0.454	0.495	0.527	0.555	0.488	0.357	0.29
Gd	5.27	5.76	6.94	7.3	7.24	6.51	5.44	4.2
Tb	3.6	3.97	5.2	5.32	5.29	4.07	3.08	2.269
Dy	64.29	73.42	96.38	93.6	84.41	52.94	41.41	29.93
Ho	24.53	26.84	37.02	35.1	26.46	14.69	10.92	7.08
Er	95.71	103.02	149.46	132.46	89.99	46.46	34.19	21.91
Tm	14.06	15.87	23.59	20.1	13.03	6.7	4.74	3.33
Yb	96.3	109.25	163.36	141.46	87.96	45.95	34.05	24
Lu	11.59	13.29	19.55	17.17	11.08	6.3	5.23	3.63
Hf	0.127	0.141	0.151	0.123	0.094	0.081	0.123	0.108

One Sigma Error

	8AG2_01	8AG2_02	8AG2_03	8AG2_04	8AG2_05	8AG2_06	8AG2_07	8AG2_08	8AG2_09
Na	5.06	6.44	7.31	6.84	6.22	7.16	7.93	7.66	6.68
Mg	793.36	622.92	530.53	482.91	441.28	437.64	399.33	369.38	355.22
Al	3585.24	3779.24	3642.02	3650.37	3737.38	3812.71	3690.54	3588.43	3409.33
Si^{29}	8059.15	8304.42	7959.97	8165.39	8040.3	8810.65	8301.81	8124.4	8004.87
Si^{30}	8237.72	8222.87	8608.57	8475.36	8655.86	9228.69	8820.48	8089.48	7906
P	16.67	15.61	18.19	17.63	34.38	17.23	136.89	16.96	14.09
Ca^{43}	1041.34	1311.87	1295.81	1355.56	1489.44	1610.97	1606.66	1625.46	1573.73
Ca^{44}	1010.82	1259.01	1279.79	1317.31	1481.15	1606.01	1604.97	1624.29	1606.79
Sc	8.75	8.17	8.28	8.31	9.81	12.52	13.06	12.2	10.29
Ti	15.56	16.17	17.32	18.36	22.09	25.34	26.83	25.04	25.94
Mn	500.01	699.15	842.17	1068.06	1402.88	1715.08	1845.73	1930.71	1945.25
Fe	6652.57	6921.92	6514.72	6352.35	6068.46	6081.98	6051.78	5600.52	5389.42
Y	13.72	23.64	35.93	35.8	27.87	26.07	22.02	29.46	27.26
Zr	0.24	0.17	0.17	0.16	0.15	0.16	0.16	0.12	0.13
La	0.0053	0.0034	0.0099	0.0016	0.0046	0.0049	0.0077	0.0068	0.0047
Ce	0.0071	0.0061	0.0095	0.0048	0.0089	0.0021	0.011	0.0043	0.0018
Pr	0.0042	0.0023	0.0029	0.0026	0.0048	0.0045	0.0061	0.0017	0.0032
Nd	0.048	0.03	0.043	0.032	0.038	0.03	0.043	0.037	0.039
Sm	0.063	0.069	0.062	0.068	0.062	0.061	0.06	0.051	0.044
Eu	0.043	0.047	0.043	0.039	0.035	0.034	0.032	0.026	0.02
Gd	0.4	0.4	0.4	0.34	0.31	0.3	0.23	0.19	0.16
Tb	0.16	0.21	0.21	0.18	0.16	0.14	0.11	0.087	0.071
Dy	2.19	3.1	3.89	3.51	2.85	2.63	2.06	1.88	1.6
Ho	0.56	0.9	1.33	1.31	1.03	0.94	0.78	0.99	0.9
Er	1.52	2.57	4.28	4.65	3.47	3.22	2.73	4.71	4.97
Tm	0.25	0.41	0.72	0.83	0.61	0.54	0.51	1.07	1.25
Yb	1.35	2.31	4.17	5.03	3.52	3.19	3.02	6.78	9.13
Lu	0.21	0.32	0.57	0.7	0.5	0.48	0.49	1.08	1.62
Hf	0.032	0.026	0.031	0.026	0.022	0.02	0.026	0.029	0.023

One Sigma Error

	8AG2_10	8AG2_11	8AG2_12	8AG2_13	8AG2_14	8AG2_15	8AG2_16	8AG2_17	8AG2_18
Na	7.08	7.91	8.26	8.48	8.07	8.04	8.82	9.59	8.16
Mg	360.89	350.66	357.95	375.51	375.44	377.01	402.15	432.11	442.99
Al	3586.76	3553.32	3623.61	3710.63	3739.16	3491.37	3494.7	3715.63	3556.65
Si^{29}	8314.28	8401.86	8492.43	8686.28	8315.02	8282.8	8101.79	9165.88	8942.4
Si^{30}	3936.14	8770.95	9398.15	9182.21	9487.88	8907.97	8901.61	9485.72	9292.45
P	18.55	19.66	14.17	18.01	19.47	13.4	15.8	19.92	17.06
Ca^{43}	1731.41	1810.11	1871.84	1922.59	1970.87	1821.18	1781.08	1835.07	1803.17
Ca^{44}	1720.51	1808.84	1876.52	1963.17	1941.08	1864.25	1854.04	1888.65	1838.5
Sc	10.5	10.22	9.44	9.72	9.48	10.82	11.01	11.89	12.62
Ti	27.34	26.02	24.56	25.8	26.26	28.04	28.27	30.94	30.68
Mn	1992.1	2049.93	2059.62	2112.17	2122.49	2032	2004.53	2083.8	1899.89
Fe	5462.41	5554.15	5480.13	5619.61	5542.43	5497.78	5655.84	5978.93	5988.02
Y	25.01	20.98	20	20.57	21.69	21.84	29.29	34.64	25.01
Zr	0.13	0.12	0.11	0.11	0.12	0.13	0.14	0.13	0.17
La	0.0048	0.0027	0.0018	0.0043	0.0025	0.0053	0.0053	0.0034	0.0037
Ce	0.0036	0.0054	0.0038	0.0044	0.0061	0.0054	0.0048	0.0053	0.0016
Pr	0.0032	0.0015	0.0048	<0.00	0.0019	0.005	0.0037	0.0052	0.0026
Nd	0.033	0.025	0.044	0.033	0.054	0.03	0.029	0.036	0.041
Sm	0.038	0.046	0.036	0.053	0.044	0.045	0.039	0.058	0.056
Eu	0.022	0.019	0.018	0.015	0.017	0.021	0.022	0.022	0.033
Gd	0.15	0.12	0.12	0.11	0.13	0.13	0.16	0.2	0.27
Tb	0.064	0.053	0.046	0.043	0.05	0.054	0.074	0.099	0.12
Dy	1.37	1.01	0.96	0.96	1.04	1.16	1.78	2.23	2.3
Ho	0.83	0.68	0.64	0.67	0.7	0.71	0.98	1.17	0.88
Er	5.12	5.14	5.05	5.38	5.44	4.54	5.21	5.3	3.01
Tm	1.55	1.95	2.2	2.37	2.42	1.55	1.39	1.26	0.59
Yb	12.71	20.55	26.81	28.39	28.68	13.89	10.05	7.99	3.38
Lu	2.45	4.7	6.95	7.52	7.6	2.96	1.85	1.33	0.59
Hf	0.022	0.017	0.019	0.018	0.029	0.022	0.017	0.026	0.024

One Sigma Error

	8AG2_19	8AG2_20	8AG3_21	8AG3_22	8AG3_23	8AG3_24	8AG3_25	8AG3_26
Na	8.43	7.92	8.11	7.51	6.92	6.34	6.72	5.76
Mg	485.8	535.75	543.44	591.7	650.65	724.71	896.33	1053.75
Al	3688.87	3533.2	3715.67	3688.88	3682.22	3529.9	3781.01	3615.26
Si^{29}	8876.89	8749.51	7966.32	7892.44	7903.34	8176.6	8791.02	8448.65
Si^{30}	9293.57	9026.86	8509.58	9009.95	9016.43	8397.31	9380.52	8735.48
P	17.74	16.68	22.12	17.03	22.54	17.96	19.67	20.89
Ca^{43}	1833.78	1681.7	1594.2	1481.97	1507.57	1485.25	1686.34	1531.45
Ca^{44}	1899.55	1692.71	1461.39	1331.53	1376.76	1361.1	1554.05	1401.68
Sc	13.13	10.49	9.26	8.41	9.15	9.84	9.89	8.38
Ti	30.66	25.72	27.16	23.19	23	21.26	23.32	22
Mn	1734.25	1448.44	1163.11	945.61	735.02	501.23	359.97	365.31
Fe	6212.04	6306.62	7790.27	8378.19	8529.85	8373.77	9510.04	9355.85
Y	29.54	31.88	31.94	30.03	21.92	12.18	8.99	6.02
Zr	0.17	0.17	0.15	0.13	0.15	0.14	0.17	0.15
La	0.0058	0.0051	<0.00	0.0018	0.0048	0.0062	0.0026	0.0083
Ce	0.0058	0.0036	0.0053	<0.00	0.0041	0.0033	0.0071	0.0044
Pr	0.0038	0.0042	0.0022	0.0021	0.0024	0.0016	0.0036	0.0047
Nd	0.045	0.045	0.041	0.044	0.045	0.02	0.042	0.047
Sm	0.064	0.07	0.073	0.075	0.097	0.067	0.082	0.064
Eu	0.034	0.038	0.041	0.043	0.044	0.04	0.039	0.03
Gd	0.31	0.33	0.35	0.35	0.37	0.33	0.32	0.25
Tb	0.15	0.16	0.18	0.18	0.19	0.15	0.12	0.091
Dy	2.88	3.31	3.42	3.36	3.1	2.01	1.65	1.22
Ho	1.08	1.19	1.23	1.17	0.9	0.52	0.4	0.27
Er	3.48	3.76	4.69	4.17	2.88	1.52	1.17	0.76
Tm	0.63	0.72	0.77	0.66	0.44	0.24	0.18	0.13
Yb	3.63	4.14	5.3	4.63	2.95	1.6	1.25	0.9
Lu	0.55	0.64	0.63	0.56	0.37	0.22	0.19	0.14
Hf	0.024	0.025	0.039	0.025	0.032	0.034	0.034	0.024

TABLE 4C LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	10A_G1_01	10A_G1_02	10A_G1_03	10A_G1_04	10A_G1_05	10A_G1_06	10A_G1_07	10A_G1_08	10A_G1_09
Distance across:	43.19	124.66	214.85	298.81	380.65	470.48	551.96	624.35	707.24
Element:									
Na	88.82	83.69	101.2	97.44	116.95	155.61	153.42	164.94	168.58
Mg	16684.69	21420.25	22272.08	22344.53	21656.46	20725.63	21132.94	21467.22	21319.95
Al	113100.84	119610.6	119240.13	120034.01	117281.91	117176.05	117228.98	120139.86	120086.93
Si^{29}	177170.27	189045.28	186118.05	186668.33	182813.3	181383.77	183007.61	189123.44	185770.27
Si^{30}	172354.39	187497.92	184908.41	183285.8	181267.48	179910.91	180672.02	185802.48	186484.31
P	40.41	88.38	125.44	142.33	134.31	158.28	146.52	153.94	155.17
Ca^{43}	10777.12	11008.59	10910.45	11032.89	10680.83	10940.08	11463.4	12107.1	11928.8
Ca^{44}	10435.31	10264.95	9960.39	9872.8	9710.34	10151.44	10676.01	11090.29	11116.49
Sc	196.8	255.27	219.47	203.72	177.34	150.47	154.07	158.59	158.32
Ti	23.6	42.76	81.95	120.69	217.48	315.04	362.74	413.56	425.78
Mn	27885.08	27909.24	28731	31284.12	33787.72	35269.12	36888.13	39329.58	40188.22
Fe	197666.27	208495.53	209149.11	208893.84	203641.58	201479.95	202321.53	207171.58	205716.88
Y	575.25	492.22	693.21	827.17	1039.03	1255.29	1270.96	1331.77	1369.44
Zr	2.2	6.01	10.37	13.57	15.5	14.91	16.09	15.89	15.9
La	BDL	0.002	BDL	0.00093	BDL	BDL	BDL	BDL	0.0027
Ce	0.0022	BDL	BDL	0.0078	0.0046	BDL	0.0115	0.0103	BDL
Pr	BDL	0.0016	BDL	BDL	BDL	0.0111	0.0127	0.0225	0.0184
Nd	BDL	0.104	0.124	0.15	0.135	0.297	0.43	0.496	0.535
Sm	0.418	0.398	0.509	0.952	1.54	2.51	2.57	2.93	2.82
Eu	0.053	0.051	0.0717	0.068	0.146	0.258	0.272	0.335	0.275
Gd	5.73	5.11	8.13	10.61	17.32	20.74	22.85	23.33	24.68
Tb	3.91	3.02	4.55	6.05	8.61	10.73	11.25	12	12.46
Dy	69.58	50.95	79.32	98.8	127.35	144.27	154.06	160.06	164.16
Ho	29.85	23.4	34.46	40.74	45.38	47.62	47.91	48.29	49.52
Er	120.34	120.18	167.75	189.2	187.34	195.67	191.03	187.83	192.44
Tm	16.53	23.62	32.34	35.63	33.27	36.15	34.94	33.26	34.44
Yb	95.49	200.68	265.51	288.17	261.63	296.87	282.64	260.45	267.81
Lu	12.69	37.23	47.79	50.97	40.21	47.63	43.6	38.92	40
Hf	0.074	0.161	0.26	0.293	0.279	0.441	0.356	0.436	0.419

TABLE 4C LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	10A_G1_10	10A_G1_11	10A_G1_12	10A_G1_13	10A_G1_14	10A_G1_15	10A_G1_16	10A_G1_17	10A_G1_18
Distance across:	779.38	874.33	956.59	1043.31	1133.16	1221.77	1313.25	1405.63	1477.2
Element:									
Na	164.22	166.62	171.41	160.94	157.12	148.83	141.01	146.98	122.14
Mg	20370.79	20507.97	20885.63	20709.26	21433.54	21017.9	20193.63	22199	21462.74
Al	115429.52	115641.18	118710.84	117599.41	120880.77	118552.06	113947.58	120033.96	114318.06
Si^{29}	178937.19	183199	186481.56	182937	183053.64	182506.47	177447.38	186834.06	179494.03
Si^{30}	174029.2	183107.14	189440.53	184351.58	190990.27	180978.67	166135.88	180461.25	173577.19
P	164.29	132.64	156.91	200.28	192.37	182.35	253.12	196.1	174.21
Ca^{43}	11483.2	11953.21	12379.83	11281.53	11587.9	11318.45	11381.8	12259.02	11175.75
Ca^{44}	10721.71	11101.79	11522.01	10564.34	10798.13	10440.63	10695.98	11242.79	9854.97
Sc	149.97	148.08	153.85	167.06	177.72	183.58	174.5	171.31	170.29
Ti	397.19	404.34	423.62	553.09	559.37	568.03	475.82	483.14	313.29
Mn	39554.73	40182.93	40426.01	39808.13	40931.64	39518.02	35327.77	37814.16	34344.39
Fe	200043.13	204365.84	208757.48	206261	208033.42	210498.78	199891.31	214888.63	207803.13
Y	1347.41	1382.35	1416.35	1220.97	1199.79	1111.42	902.25	1008.09	890.94
Zr	13.81	14.04	14.84	17.75	17.34	18.42	18.46	17.6	16.34
La	BDL	BDL	0.0025	BDL	BDL	BDL	12.39	2.39	0.526
Ce	0.0098	BDL	0.0159	0.0223	0.0188	0.0173	23.46	5.42	2.66
Pr	0.0157	0.0106	0.0133	0.0181	0.0181	0.0199	2.87	0.629	0.189
Nd	0.432	0.497	0.499	0.508	0.489	0.518	11.25	3.02	1.27
Sm	2.59	2.76	2.81	2.77	2.74	2.75	4.69	3.23	2.87
Eu	0.295	0.242	0.325	0.286	0.302	0.257	0.405	0.302	0.26
Gd	23.99	24.1	25.37	22.82	22.58	21.71	24.39	24.64	21.03
Tb	12.14	11.95	12.53	11.15	11.35	10.8	10.57	11.12	10.07
Dy	161.03	161.16	168.2	149.26	143.78	139.3	120.44	133.32	120.64
Ho	48.9	50.58	52.4	43.98	42.82	39.63	30.61	34.49	31.45
Er	193.29	203.54	202.68	169.57	159.86	142.75	99.43	116.33	104.99
Tm	34.73	37.09	36.37	29.81	27.73	24.19	15.18	19	16.47
Yb	279	296.65	289.22	229.97	212.91	178.29	106.56	138.12	113.32
Lu	41.65	45.45	43.09	32.9	30.14	24.52	13.67	18.11	15.14
Hf	0.374	0.358	0.441	0.412	0.455	0.416	0.468	0.499	0.385

TABLE 4C LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	10A_G1_19	10A_G1_20	10A_G1_21	10A_G1_22	10A_G1_23
Distance across:	1568.3	1652.26	1748.22	1832.79	1921.33
Element:					
Na	130.28	114.12	95.76	73.95	72.75
Mg	22164.36	22445.06	22667.92	21047.8	20775.13
Al	116011.66	117070.16	117440.63	110666.23	119293.02
Si^{29}	180503.67	182261.13	181171.39	170541.08	187202.47
Si^{30}	180699.11	182516.13	184078.23	168267.42	189779.11
P	166.36	141.16	117.85	102.01	65.28
Ca^{43}	10823.25	10691.01	10740.95	9733.78	11047.1
Ca^{44}	9820.79	9808.11	9577.96	8771.79	9911.19
Sc	149.1	161.5	175.74	207.69	228.81
Ti	262.41	194.49	134.76	51.18	32.51
Mn	33493.55	31926.96	30123.23	26943.26	29773.56
Fe	211636.92	213928.36	216771.72	206254.67	227601
Y	1128.1	1037.99	918.13	515.36	462.52
Zr	15.57	14.7	13.04	7.26	3.54
La	0.626	0.257	0.109	0.093	0.131
Ce	1.091	0.385	0.273	0.234	0.156
Pr	0.139	0.0864	0.0255	0.0208	0.0191
Nd	0.819	0.61	0.315	BDL	0.104
Sm	2.31	1.82	0.918	0.463	0.432
Eu	0.22	0.192	0.143	0.052	0.0424
Gd	20.72	18.43	13.38	6.38	4.57
Tb	10.45	9.36	7.35	3.52	2.8
Dy	139.11	126.97	111.19	57.73	49.1
Ho	40.92	39.87	40.31	24.98	22.17
Er	152.22	151.37	165	126.08	106.98
Tm	25.98	25.69	29.62	24.26	19.4
Yb	192.97	191.65	224.43	204.7	147.05
Lu	26.19	26.95	33.48	37.3	25.8
Hf	0.434	0.339	0.276	0.174	0.11

One Sigma Error

	10A_G1_01	10A_G1_02	10A_G1_03	10A_G1_04	10A_G1_05	10A_G1_06	10A_G1_07	10A_G1_08	10A_G1_09
Na	4.2	3.68	4.08	4.02	4.55	5.73	5.69	6.12	6.28
Mg	525.28	675.14	703.12	706.8	686.62	658.85	673.79	686.72	684.48
Al	3576.77	3782.51	3770.78	3795.89	3708.87	3705.52	3707.18	3799.24	3797.56
Si^{29}	7578.21	8132.48	8066.33	8161.45	8073.54	8100.84	8274.64	8666.9	8636.94
Si^{30}	6814.47	7399.59	7308.03	7257.54	7190.63	7151.51	7194.38	7414.34	7456.52
P	11.93	17.25	23.25	26.22	25.03	29.27	27.4	28.93	29.3
Ca^{43}	380.58	368.61	365.32	371.36	362.85	372.99	390.46	416.26	413.16
Ca^{44}	344.84	335.65	326.82	325.83	322.32	338.6	357.31	374.08	377.86
Sc	6.15	7.92	6.82	6.34	5.53	4.7	4.82	4.97	4.97
Ti	1.38	1.71	2.97	4.25	7.49	10.78	12.41	14.27	14.82
Mn	881.12	884.4	913.77	999.39	1084.97	1139.26	1199.49	1288.31	1327.04
Fe	6666.23	7081.02	7167.9	7237.29	7144.44	7169.2	7312.24	7615.76	7701.26
Y	17.81	15.24	21.49	25.7	32.36	39.2	39.82	41.88	43.24
Zr	0.13	0.23	0.37	0.47	0.54	0.53	0.56	0.57	0.57
La	0.0053	0.0014	0.003	0.00093	0.0038	0.0054	0.0041	0.0042	0.0015
Ce	0.0022	0.0039	0.0034	0.0026	0.0021	0.0048	0.003	0.003	0.0048
Pr	0.0047	0.0011	0.0025	0.0033	0.0032	0.0039	0.0038	0.0041	0.0037
Nd	0.041	0.022	0.028	0.04	0.045	0.042	0.053	0.057	0.058
Sm	0.079	0.058	0.062	0.081	0.11	0.15	0.14	0.16	0.15
Eu	0.015	0.011	0.01	0.011	0.015	0.021	0.02	0.024	0.021
Gd	0.33	0.23	0.33	0.41	0.63	0.74	0.8	0.83	0.88
Tb	0.15	0.11	0.15	0.2	0.28	0.35	0.36	0.39	0.4
Dy	2.35	1.69	2.62	3.27	4.23	4.83	5.19	5.45	5.65
Ho	0.97	0.75	1.1	1.31	1.46	1.54	1.56	1.58	1.64
Er	3.82	3.76	5.24	5.93	5.89	6.17	6.04	5.97	6.15
Tm	0.59	0.82	1.13	1.26	1.19	1.31	1.29	1.25	1.32
Yb	3.23	6.59	8.75	9.57	8.77	10.04	9.66	9.02	9.39
Lu	0.42	1.17	1.5	1.6	1.27	1.51	1.38	1.24	1.28
Hf	0.029	0.023	0.031	0.036	0.037	0.04	0.036	0.037	0.036

One Sigma Error

	10A_G1_10	10A_G1_11	10A_G1_12	10A_G1_13	10A_G1_14	10A_G1_15	10A_G1_16	10A_G1_17	10A_G1_18
Na	6.21	5.69	5.86	5.56	5.5	5.28	5.24	5.25	4.67
Mg	656.6	684.45	698.66	693.92	719.63	707.33	683.49	753.83	731.53
Al	3650.29	3656.97	3754.04	3718.9	3822.67	3749.02	3603.47	3795.89	3615.2
Si^{29}	8448.12	8021.81	8189.74	8050.7	8075.26	8073.25	7902.99	8351.46	8058.4
Si^{30}	6978.02	7389.34	7665.41	7472.16	7752.81	7361.45	6796.34	7379.78	7118.35
P	31.03	25.43	29.77	37.58	36.26	34.54	47.72	37.18	33.48
Ca^{43}	402.64	400.21	414.59	381.05	391.48	381.91	395.69	416.02	392.69
Ca^{44}	368.25	366.86	381.29	351.18	359.64	348.86	361.12	377.63	335.2
Sc	4.72	4.56	4.74	5.15	5.48	5.65	5.39	5.28	5.27
Ti	14	13.51	14.16	18.47	18.71	19	16.26	16.35	10.98
Mn	1317.51	1408.55	1422.46	1404.65	1449.18	1404.68	1267.86	1364.7	1247.11
Fe	7635.09	7265.76	7457.24	7392.85	7486.11	7609.67	7307.13	7905.18	7698.77
Y	42.73	44.17	45.32	39.12	38.49	35.71	29.12	32.59	28.89
Zr	0.51	0.47	0.49	0.59	0.58	0.61	0.63	0.59	0.57
La	0.0047	0.0028	0.0015	0.0042	0.003	0.003	0.42	0.089	0.034
Ce	0.0043	0.0051	0.0036	0.0054	0.0042	0.0038	0.92	0.22	0.12
Pr	0.0043	0.0036	0.003	0.0051	0.0052	0.0037	0.11	0.03	0.017
Nd	0.054	0.052	0.05	0.055	0.061	0.049	0.48	0.15	0.11
Sm	0.14	0.15	0.15	0.16	0.15	0.15	0.26	0.17	0.19
Eu	0.022	0.02	0.022	0.022	0.023	0.021	0.033	0.023	0.028
Gd	0.86	0.83	0.87	0.79	0.79	0.75	0.89	0.85	0.79
Tb	0.4	0.38	0.4	0.36	0.37	0.35	0.35	0.36	0.34
Dy	5.62	5.21	5.45	4.85	4.68	4.54	3.98	4.38	4.02
Ho	1.63	1.62	1.68	1.41	1.38	1.28	1	1.12	1.03
Er	6.21	6.29	6.27	5.26	4.96	4.43	3.13	3.63	3.31
Tm	1.35	1.23	1.21	1	0.93	0.82	0.53	0.65	0.58
Yb	9.92	9.69	9.47	7.56	7.01	5.89	3.59	4.61	3.85
Lu	1.34	1.41	1.34	1.03	0.94	0.77	0.44	0.57	0.49
Hf	0.035	0.033	0.04	0.038	0.041	0.038	0.048	0.04	0.046

One Sigma Error

	10A_G1_19	10A_G1_20	10A_G1_21	10A_G1_22	10A_G1_23
Na	4.82	4.44	4.03	3.39	3.5
Mg	758.4	771.29	782.52	730.13	724.39
Al	3668.69	3702.17	3713.89	3499.65	3772.46
Si^{29}	8138.89	8258.08	8251.1	7809.37	8621.72
Si^{30}	7417.27	7507.76	7588.16	6951.86	7853.99
P	31.93	27.59	23.68	20.66	14.95
Ca^{43}	371.23	369.47	372.25	338.55	384.6
Ca^{44}	334.03	335.26	329.28	302.87	342.68
Sc	4.6	4.98	5.42	6.4	7.05
Ti	9.08	6.86	4.87	2.01	1.39
Mn	1224.26	1175.31	1117.31	1007.37	1122.58
Fe	7899.32	8049.53	8226.66	7898.65	8799.42
Y	36.67	33.84	30.03	16.92	15.24
Zr	0.52	0.5	0.45	0.26	0.14
La	0.032	0.019	0.012	0.01	0.013
Ce	0.053	0.025	0.02	0.018	0.014
Pr	0.011	0.0088	0.0053	0.0047	0.0047
Nd	0.071	0.064	0.047	0.043	0.039
Sm	0.13	0.12	0.079	0.051	0.054
Eu	0.018	0.019	0.016	0.011	0.0093
Gd	0.73	0.67	0.51	0.27	0.22
Tb	0.34	0.31	0.24	0.12	0.1
Dy	4.6	4.22	3.71	1.95	1.68
Ho	1.33	1.3	1.32	0.83	0.74
Er	4.75	4.73	5.16	3.95	3.37
Tm	0.89	0.89	1.03	0.85	0.68
Yb	6.47	6.46	7.58	6.95	5.03
Lu	0.83	0.85	1.06	1.18	0.82
Hf	0.038	0.035	0.034	0.03	0.023

TABLE 4D LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	17B_G1_01	17B_G1_02	17B_G1_03	17B_G1_04	17B_G1_05	17B_G1_06	17B_G1_07	17B_G1_08	17B_G1_09
Distance across:	45.3	100.67	160.12	226.71	285.54	342.53	407.28	468.17	539.04
Element:									
Na	110.19	107.01	143.72	161.02	183.36	138.85	128.08	138.67	151.78
Mg	23455.31	24882.55	27710.37	25719.94	25877.44	22233.72	23178.57	25664.66	23949.81
Al	118181.62	110507.48	116472.14	117768.82	115593.59	115461.27	116593.87	119134.26	118128.7
Si^{29}	184473.02	177921.83	190989.39	193674.19	188672.91	185224.86	190539.28	191626.78	187552.77
Si^{30}	182252.17	180418.44	195602.48	196455.8	188530.2	189848.19	187940.45	206232.44	202466.72
P	224.39	310.47	432.68	515.52	448.73	899.19	610.08	406.61	645.32
Ca^{43}	10084.62	9388.16	10751.75	10248.08	10218.62	10277.04	11503.76	12407.69	11589.5
Ca^{44}	9264	8553.4	9976.34	9899.58	9451.26	9896.38	10424.99	11640.94	11098.72
Sc	137.64	129.92	120.18	139.7	131.52	130.8	124.31	139.57	145.74
Ti	169.12	282.07	504.24	668.61	689.19	574.41	593.78	634.2	713.75
Mn	23868.77	20479.58	24674.27	23785.29	27428.26	24574.42	29832.24	31776.06	30988.21
Fe	228887.11	211879.78	237464.06	216729.06	222575.42	201139.77	212074.31	221366.72	215823.67
Y	285.97	151.87	128.04	130.39	99.47	79.75	97.23	105.51	88.13
Zr	13.09	21.53	26.29	34.33	27.49	23.88	22.02	24.32	26.29
La	0.073	0.0093	0.015	0.024	BDL	0.034	0.0283	0.0187	0.024
Ce	0.117	0.0463	0.087	0.069	0.0388	0.262	0.15	0.088	0.179
Pr	0.023	<0.0095	0.0199	BDL	0.0102	0.0291	0.0392	BDL	0.0316
Nd	0.202	0.263	0.276	0.41	0.221	0.375	0.278	0.439	0.309
Sm	1.72	1.18	1.61	1.65	1.31	1.55	1.77	1.73	1.33
Eu	0.362	0.297	0.338	0.407	0.401	0.382	0.492	0.511	0.451
Gd	17.81	9.78	9.23	8.09	6.55	7.03	6.99	7.4	5.96
Tb	6.6	3.45	3.07	2.56	1.999	1.839	2.024	2.041	1.817
Dy	53.53	27.74	23.62	21.39	16.82	13.95	16.03	16.43	14.01
Ho	9.22	5.27	4.29	4.4	3.44	2.64	3.24	3.42	2.79
Er	21.66	13.84	11.02	13.7	10.73	7.88	9.74	10.58	8.8
Tm	2.677	1.784	1.476	2.13	1.438	0.974	1.367	1.603	1.284
Yb	15.66	10.43	8.56	12.37	10.21	6.4	9.29	10.07	9.11
Lu	2.163	1.529	1.149	1.8	1.498	0.819	1.227	1.419	1.193
Hf	0.273	0.445	0.546	0.657	0.549	0.42	0.434	0.38	0.542

TABLE 4D LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	17B_G1_10	17B_G1_11	17B_G1_12	17B_G1_13	17B_G1_14
Distance across:	611.59	686.94	762.85	824.94	874.197
Element:					
Na	151.26	148.16	168.23	119.42	96.3
Mg	24580.15	25836.74	24136.69	25027.59	24380.11
Al	118816.71	116435.09	113735.91	114053.46	113841.76
Si^{29}	186382.03	197044.44	272516.91	186605.59	189181.25
Si^{30}	199811.84	200353.56	269869.13	188098.56	199500.08
P	640.32	486.39	596.67	416.48	240.83
Ca^{43}	11243.72	10762.14	9729.09	9865.51	9107.23
Ca^{44}	10796.29	10493.89	8961.21	9202.62	8402.26
Sc	155.13	135.48	108.87	101.63	118.69
Ti	724.54	710.05	449.84	369.96	188.71
Mn	28909.51	27010.35	20978.31	22084.76	23914.75
Fe	215208.3	221267.25	195949.11	213014.11	235284.27
Y	74.92	54.46	53.1	64.14	125.09
Zr	29.97	28.1	25.46	23.6	15.56
La	0.055	0.0118	0.038	BDL	0.0066
Ce	0.232	0.0307	0.202	0.0369	0.0115
Pr	0.0428	0.016	0.036	0.0109	0.0141
Nd	0.477	0.367	0.3	0.183	0.13
Sm	1.39	1.206	0.93	1.138	0.815
Eu	0.452	0.342	0.303	0.333	0.228
Gd	6.39	5.35	5.1	5.61	7.4
Tb	1.702	1.459	1.515	1.697	2.566
Dy	12.52	10.07	9.58	11.53	22
Ho	2.218	1.72	1.607	1.962	4.18
Er	6.59	4.41	4.56	5.44	11.29
Tm	0.979	0.638	0.635	0.75	1.487
Yb	5.99	3.91	3.75	5.02	9.21
Lu	0.811	0.49	0.519	0.664	1.233
Hf	0.575	0.42	0.453	0.41	0.262

One Sigma Error

	17B_G1_01	17B_G1_02	17B_G1_03	17B_G1_04	17B_G1_05	17B_G1_06	17B_G1_07	17B_G1_08	17B_G1_09
Na	5.06	5.03	6.2	7.51	7.55	6.24	5.11	5.38	5.87
Mg	860.88	920.42	1033.33	967.12	981.22	850.43	746.57	827.15	772.57
Al	3737.35	3494.66	3683.35	3724.48	3655.51	3651.39	3687.2	3767.46	3735.7
Si^{29}	7924.64	7660.92	8244.44	8384.45	8183.85	8057.11	8189.03	8241.47	8076.09
Si^{30}	11735.57	11812.52	13019.56	13329.39	12982.45	13308.05	8243.58	9046.86	8902.16
P	43	58.94	81.8	98.13	85.07	170.13	113.63	75.88	119.72
Ca^{43}	355.34	333.42	391.46	395.79	366.03	381.03	385.18	399.69	382.68
Ca^{44}	300.95	281.06	322.72	336.9	305.21	322.33	336.41	371.92	357.94
Sc	4.31	4.07	3.79	4.45	4.13	4.13	4.23	4.72	4.95
Ti	6.57	10.76	19.32	26.01	26.39	22.46	21.71	22.95	26
Mn	800.49	690.05	835.44	809.43	938.15	845.05	985.1	1050.48	1026
Fe	7679.85	7141.76	8042.74	7378.11	7612.99	6916.54	6774.28	7074.91	6904.5
Y	8.74	4.65	3.94	4.04	3.06	2.47	3.08	3.33	2.8
Zr	0.46	0.72	0.9	1.2	0.92	0.83	0.75	0.79	0.86
La	0.012	0.0035	0.0057	0.011	0.0066	0.013	0.0086	0.0082	0.01
Ce	0.014	0.0078	0.014	0.018	0.0073	0.026	0.018	0.011	0.018
Pr	0.0075	0.0046	0.0067	0.009	0.0034	0.0094	0.0087	0.0064	0.0081
Nd	0.056	0.054	0.066	0.1	0.067	0.07	0.064	0.058	0.067
Sm	0.13	0.11	0.15	0.19	0.11	0.15	0.16	0.12	0.13
Eu	0.029	0.027	0.035	0.048	0.032	0.038	0.042	0.035	0.037
Gd	0.67	0.41	0.44	0.48	0.31	0.37	0.36	0.33	0.31
Tb	0.22	0.12	0.12	0.12	0.078	0.081	0.085	0.077	0.075
Dy	1.82	0.98	0.89	0.88	0.63	0.57	0.62	0.59	0.54
Ho	0.31	0.19	0.16	0.18	0.13	0.11	0.13	0.12	0.11
Er	0.72	0.48	0.42	0.55	0.39	0.32	0.39	0.39	0.35
Tm	0.099	0.07	0.069	0.1	0.061	0.052	0.064	0.064	0.058
Yb	0.58	0.41	0.38	0.57	0.4	0.31	0.39	0.38	0.37
Lu	0.087	0.066	0.06	0.095	0.065	0.048	0.063	0.061	0.058
Hf	0.037	0.046	0.065	0.087	0.053	0.056	0.056	0.041	0.058

One Sigma Error

	17B_G1_10	17B_G1_11	17B_G1_12	17B_G1_13	17B_G1_14
Na	6.17	5.73	7.74	4.89	4.42
Mg	793.76	835.32	781.57	811.6	792.03
Al	3757.5	3682.1	3596.93	3606.78	3600.1
Si^{29}	8037.11	8506.72	11788.54	8084.21	8212.72
Si^{30}	8817.59	8838.91	11975.67	8338.58	8867.96
P	118.84	90.14	111.32	77.1	45.33
Ca^{43}	378.95	349.18	352	320.46	300.63
Ca^{44}	354.53	338.87	327.09	300.05	278.72
Sc	5.29	4.62	3.81	3.49	4.09
Ti	26.61	25.91	17.24	13.79	7.28
Mn	958.98	897.93	699.25	738.19	801.93
Fe	6892.9	7095.09	6295.35	6852.52	7583.5
Y	2.39	1.73	1.73	2.04	3.97
Zr	0.99	0.9	0.9	0.76	0.52
La	0.014	0.0038	0.014	0.0038	0.003
Ce	0.024	0.0069	0.028	0.0063	0.0053
Pr	0.0087	0.0039	0.011	0.0032	0.005
Nd	0.075	0.05	0.11	0.041	0.051
Sm	0.14	0.1	0.14	0.097	0.082
Eu	0.04	0.027	0.041	0.026	0.023
Gd	0.35	0.26	0.35	0.26	0.34
Tb	0.075	0.058	0.08	0.065	0.094
Dy	0.51	0.39	0.46	0.43	0.78
Ho	0.096	0.069	0.086	0.076	0.15
Er	0.29	0.18	0.25	0.22	0.42
Tm	0.052	0.032	0.047	0.036	0.061
Yb	0.29	0.18	0.25	0.21	0.36
Lu	0.048	0.029	0.043	0.035	0.056
Hf	0.063	0.046	0.076	0.039	0.035

TABLE 4E LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	22AG3_01	22AG3_02	22AG3_03	22AG3_04	22AG3_05	22AG3_06	22AG3_07	22AG3_08	22AG3_09
Distance across:	0	72.1	199.6	304.4	400.4	503.39	606.38	706.48	809.98
Element:									
Na	42.93	63.96	66.27	67.27	77.99	96.35	97.75	63.15	73.3
Mg	26087.38	27562.79	28281.22	27471.36	26050.13	26558.39	24070.04	22167.47	24549.86
Al	110719.14	115111.92	118552.05	119345.91	115694.09	120669.04	113259.55	117758.17	120139.8
Si^{29}	168538.91	172866.34	176169.09	176265.19	172115.03	179566.02	167373.11	275456.66	215131.2
Si^{30}	184749.98	193712.55	201028.28	205741	193074.83	197690.38	176740.88	257198.06	228339.05
P	109.63	105.74	141.54	91.11	116.15	104.95	88.35	<133.04	<91.90
Ca^{43}	10754.27	10709.33	11093.71	10976.77	10608.99	11372.01	10588.03	10289.52	11591.83
Ca^{44}	9845.18	10150.76	10329.45	10414.35	10054.33	10454.46	9605.3	9456.34	10833.17
Sc	199.99	212.73	227.19	217.32	218.16	205.69	186.38	224.11	249.72
Ti	44.7	45.5	74.58	69.45	85.6	83.25	52.12	146.47	38.3
Mn	6898.87	8923.88	11643.21	14403.23	16678.76	20733.13	22602.55	24418.3	29558.4
Fe	212995.72	219765.64	223067.36	222121.75	216940.73	221063.55	204213.95	185736.5	214384.83
Y	125.51	217.42	328.71	460.55	538.17	832.81	809.53	603.74	542.55
Zr	6.09	4.82	8.06	6.29	7.43	7.13	5.42	4.81	2.74
La	0.0031	0.0031	0.0019	BDL	BDL	0.0054	0.0033	BDL	0.0094
Ce	0.0058	0.0014	0.0069	BDL	BDL	BDL	0.0031	0.052	0.0265
Pr	BDL	0.0012	BDL	0.0028	0.0013	0.0086	0.0027	BDL	0.093
Nd	BDL	0.129	0.128	0.146	BDL	0.106	0.093	BDL	0.96
Sm	0.488	0.694	0.743	0.849	0.614	0.732	0.556	0.47	0.266
Eu	0.146	0.173	0.269	0.229	0.207	0.223	0.189	0.187	0.081
Gd	5.84	8.21	11.17	12.23	10.83	12.13	11.12	8.98	6.24
Tb	2.65	3.72	5.12	5.93	5.9	7.41	6.59	5.06	3.47
Dy	24.6	38.69	58.29	71.63	77.58	106.38	96.55	76.33	60.17
Ho	5.19	8.83	13.65	18.24	23.01	33.26	31.45	24.36	23.59
Er	12.51	22.45	36.35	51.3	70.12	110.99	105.91	77.84	102.95
Tm	1.406	2.57	4.03	5.73	8.25	14.16	14.3	10.92	16.81
Yb	8.75	15.13	22.83	31.78	43.87	84.64	84.24	57.64	124.51
Lu	1.42	2.38	3.2	4.29	5.56	9.8	9.47	6.79	16.76
Hf	0.091	0.158	0.142	0.159	0.163	0.231	0.14	0.148	0.088

TABLE 4E LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	22AG3_10	22AG3_11	22AG3_12	22AG3_13	22AG3_14	22AG3_15	22AG3_16	22AG3_17	22AG3_18
Distance across:	910.78	1006.98	1107.08	1206.68	1300.78	1414.88	1529.68	1612.48	1713.28
Element:									
Na	184.87	194.43	166.76	200.65	211.58	239	277.16	257.71	206.4
Mg	21416.68	20700.33	19943.36	20819.91	20492.6	20357.76	19602.63	19674.73	21273.75
Al	116064.58	116329.2	113206.62	117811.09	116382.13	118393.29	116646.77	114794.38	119610.55
Si^{29}	165915.94	169421.19	165387.66	175524.45	170730.42	173489.77	169716.02	165994.73	178549.47
Si^{30}	179184.55	175396.5	176320.23	185539.06	183541.88	180475.38	174976.83	176404.39	193230.94
P	<55.63	<54.24	56.86	68.5	43.15	48.5	58.16	78.97	80.09
Ca^{43}	14751.86	17297.66	17715.07	19037.06	18559.18	20541.02	19444.58	17910.49	19304.14
Ca^{44}	13902.03	16395.89	16861.15	18060.62	17941.32	19050.87	18241.17	17051.71	18130.75
Sc	158.2	142.94	131.56	125.09	110.95	103.72	87.96	93.86	116.05
Ti	52.86	264.94	206.73	315.25	382.02	231.07	327.45	245.2	156.15
Mn	32894.15	34940.33	35877.43	40843.65	40683.71	41776.72	40070.18	39713.84	41544.26
Fe	200172.72	198658.08	192485.69	203802.86	199892.72	200472.81	194602.58	192369.47	202352.28
Y	2053.79	1841.5	1735.11	1999.47	2152.65	2437.46	2532.78	2323.61	1903.06
Zr	3.57	4.48	4.38	4.29	3.85	3.72	2.91	4.38	5.63
La	BDL	BDL	BDL	0.0033	0.0101	BDL	0.0063	BDL	BDL
Ce	BDL	BDL	0.0125	0.017	0.0032	0.0026	0.0179	0.009	BDL
Pr	0.0035	0.0072	0.0076	BDL	0.0054	0.0066	0.0017	0.003	0.0097
Nd	0.122	0.129	BDL	0.243	0.129	BDL	<0.126	0.123	0.176
Sm	0.61	1.14	1.05	1.24	1.02	0.7	0.647	0.711	1.16
Eu	0.214	0.419	0.513	0.437	0.499	0.318	0.242	0.365	0.438
Gd	15.33	18.37	17.7	16.11	14.49	11.83	10.05	10.98	16.27
Tb	10.66	11.32	10.57	9.88	9.74	8.03	7.23	7.55	9.74
Dy	190.49	182.44	162.51	163.38	162.81	160.62	154.72	152.03	162.41
Ho	85.27	68.9	63.04	67.4	70.01	80.59	85.16	79.36	64.69
Er	417.7	302.33	286	328.79	375.56	500.15	587.33	495.94	306.31
Tm	82.43	52.28	51.47	65.11	79.64	122.23	160.21	120.63	58.82
Yb	689.49	389.96	389.94	520.17	705.57	1177.59	1774.21	1192.2	465.77
Lu	105.8	56.95	58.11	75.08	105.5	201.9	336.12	206.82	67.41
Hf	0.245	0.33	0.252	0.23	0.359	0.18	0.225	0.295	0.276

TABLE 4E LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	22AG3_19	22AG3_20	22AG3_21	22AG3_22	22AG3_23	22AG3_24	22AG3_25	22AG3_25	22AG3_26
Distance across:	1820.18	1902.98	2013.78	2127.91	2235.35	2332.13	2434.72	2552.2	2673.03
Element:									
Na	146.72	186	510.54	92.57	80.16	114.64	86.08	86.08	97.63
Mg	20246.96	21564.03	21633.11	23578.56	22730.97	24731.49	24874.15	24874.15	26095.15
Al	114106.36	115852.88	113788.81	119134.23	115482.41	118234.52	114000.52	114000.52	114000.52
Si^{29}	164849.91	172972.34	167859.75	176631.77	159541.31	172643.53	165905.73	165905.73	170619.55
Si^{30}	176750.33	184148.63	183205.41	186319.97	174743.25	190289.42	184341.13	184341.13	181005.55
P	BDL	BDL	67.01	BDL	BDL	107.94	88.68	88.68	76.26
Ca^{43}	18147.58	17940.8	16217	12482.66	11074.27	10864.64	10457.54	10457.54	10179.39
Ca^{44}	17370.03	16957.96	15106.91	11509.96	10171.63	9950.98	9522.04	9522.04	9596.04
Sc	133.76	134.14	148.38	249.98	208.03	177.08	209.82	209.82	197.3
Ti	403.75	212.5	154.01	28.84	33.7	54.09	71.14	71.14	74.09
Mn	37646.76	38389.89	35217.98	33385.74	28685.36	28091.18	23947.65	23947.65	19934.13
Fe	193587.66	201778.23	200945.05	213323.33	203444.13	213969.58	209115.66	209115.66	213818.97
Y	1656.42	1625.96	2020.31	703.61	747.92	1014.72	710.29	710.29	649.81
Zr	5.28	4.01	4.05	3.12	3.88	4.23	5.67	5.67	5.66
La	0.0036	BDL	0.0016	BDL	0.0055	0.0019	BDL	BDL	0.0044
Ce	0.012	BDL	0.003	BDL	0.0026	BDL	BDL	BDL	BDL
Pr	0.0043	BDL	0.0051	BDL	0.0022	BDL	BDL	BDL	BDL
Nd	BDL	0.277	0.163	BDL	BDL	0.084	BDL	BDL	BDL
Sm	1.33	1.23	1.19	0.371	0.489	0.684	0.601	0.601	0.627
Eu	0.519	0.462	0.454	0.12	0.122	0.193	0.116	0.116	0.184
Gd	17.14	18.27	18.09	6.11	7.71	11.11	8.47	8.47	10.43
Tb	10.2	10.36	11.32	4	5.19	6.64	5.25	5.25	5.96
Dy	153.76	157.97	187.3	74.04	86.36	109.78	86.25	86.25	85.49
Ho	57.07	59.28	74.19	34.81	30.87	40.66	31.59	31.59	26.62
Er	245.24	252.06	343.61	182.63	115.61	163.03	123.31	123.31	87.08
Tm	42.63	43.93	64.68	36.95	17.72	26.24	17.86	17.86	11.31
Yb	311.76	317.68	512.37	306.95	108.28	176.28	109.69	109.69	64
Lu	41.76	44.67	74.27	51.67	11.79	21.64	14.85	14.85	7.83
Hf	0.234	0.347	0.248	0.099	0.162	0.204	0.185	0.185	0.163

TABLE 4E LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	22AG3_27	22AG3_28	22AG3_29
Distance across:	2783.82	2908.01	3008.81
Element:			
Na	74.73	72.09	61.81
Mg	26515.32	28337.98	28461.92
Al	114000.52	116858.47	116858.47
Si^{29}	170435.3	174109.83	176741.02
Si^{30}	198745.72	195873.84	193104.55
P	131.48	113.06	119.01
Ca^{43}	10485.75	10528.67	10868.74
Ca^{44}	9704.87	10031.42	10080.05
Sc	209.03	211.74	215.97
Ti	73.33	75.53	53.05
Mn	15929.37	12917.2	9269.74
Fe	217261.52	224658.75	224301.39
Y	454.74	370.26	184.1
Zr	6.39	8.03	6.92
La	BDL	0.0058	BDL
Ce	BDL	0.0014	0.0046
Pr	BDL	0.0034	BDL
Nd	0.113	BDL	BDL
Sm	0.838	0.703	0.471
Eu	0.227	0.234	0.169
Gd	10.79	11.75	7.71
Tb	5.3	5.46	3.34
Dy	68.93	64.24	34.85
Ho	18.6	15.53	7.75
Er	53.88	40.09	20.62
Tm	6.34	4.67	2.231
Yb	34.04	25.34	12.51
Lu	4.27	3.36	2.003
Hf	0.199	0.237	0.165

One Sigma Error

	22AG3_01	22AG3_02	22AG3_03	22AG3_04	22AG3_05	22AG3_06	22AG3_07	22AG3_08	22AG3_09
Na	3.77	4.18	4.47	4.49	4.53	4.97	4.93	13.12	7.63
Mg	881.85	932.98	958.94	933.37	887.2	906.97	824.51	762.47	847.01
Al	3501.4	3640.31	3749.13	3774.23	3658.74	3816.07	3581.75	3724.96	3799.47
Si^{29}	7827.71	8038.62	8206.59	8227.76	8053.88	8426.73	7880.25	13042.5	10210.77
Si^{30}	9711.27	10208.52	10636.76	10927.52	10311.45	10620.83	9573.71	14654.52	12690.64
P	29.91	29.48	37.26	27.41	31.79	29.94	26.64	60.8	35.6
Ca^{43}	419.72	419.08	439.35	434.9	422.22	454.1	423.23	560.37	491.45
Ca^{44}	311.47	321.21	327.71	330.33	319.08	332.06	305.71	345.4	353.74
Sc	6.47	6.89	7.37	7.06	7.09	6.7	6.09	7.63	8.22
Ti	2.13	2.15	3.33	3.1	3.69	3.66	2.46	8.66	2.42
Mn	215.94	279.42	364.75	451.47	523.16	650.88	710.23	768.47	930.93
Fe	8641.65	8947.85	9123.9	9135.35	8980.04	9218.34	8585.97	7888.82	9186.22
Y	4.25	7.35	11.12	15.6	18.28	28.36	27.67	20.9	18.74
Zr	0.33	0.27	0.43	0.34	0.4	0.39	0.31	0.45	0.21
La	0.0022	0.0022	0.0019	0.005	0.0048	0.0031	0.0024	0.018	0.0055
Ce	0.0029	0.0014	0.0035	0.005	0.0048	<0.00	0.0022	0.023	0.0089
Pr	0.0044	0.0012	0.0068	0.002	0.0013	0.0035	0.0019	<0.00	0.018
Nd	0.034	0.039	0.049	0.043	0.032	0.047	0.037	0.14	0.12
Sm	0.072	0.08	0.09	0.094	0.084	0.089	0.074	0.22	0.09
Eu	0.019	0.021	0.029	0.025	0.025	0.025	0.022	0.06	0.019
Gd	0.3	0.39	0.52	0.55	0.5	0.56	0.51	0.8	0.4
Tb	0.1	0.14	0.18	0.21	0.21	0.26	0.23	0.27	0.15
Dy	0.93	1.42	2.12	2.59	2.81	3.84	3.5	3.19	2.3
Ho	0.2	0.33	0.5	0.66	0.84	1.2	1.14	1	0.89
Er	0.46	0.78	1.23	1.71	2.32	3.64	3.48	2.91	3.46
Tm	0.066	0.11	0.17	0.23	0.32	0.55	0.55	0.51	0.67
Yb	0.36	0.58	0.85	1.14	1.54	2.91	2.9	2.45	4.35
Lu	0.068	0.1	0.14	0.18	0.23	0.39	0.38	0.36	0.68
Hf	0.02	0.027	0.038	0.028	0.035	0.035	0.034	0.084	0.028

One Sigma Error

	22AG3_10	22AG3_11	22AG3_12	22AG3_13	22AG3_14	22AG3_15	22AG3_16	22AG3_17	22AG3_18
Na	7.83	7.73	6.53	7.34	7.78	8.51	9.55	8.89	7.49
Mg	741.99	720.21	697.04	731.25	723.62	722.79	699.98	706.79	769.08
Al	3670.73	3678.96	3580.1	3725.68	3680.67	3744.21	3688.91	3630.31	3782.67
Si^{29}	7913.16	8114.75	7958.76	8491.1	8310.35	8493.99	8360.45	8230.5	8914.3
Si^{30}	10011.97	9860.24	9952.73	10562.98	10572.83	10511.73	10311.01	10499.46	11620.35
P	26.45	23.35	21.66	23.17	20.54	20.93	22.16	24.64	24.73
Ca^{43}	633.69	714.75	718.03	771.11	785.9	862.35	815.48	758.02	830.71
Ca^{44}	445.42	521.37	534.23	572.21	571.59	606.68	581.47	544.45	580.22
Sc	5.29	4.77	4.37	4.16	3.76	3.52	2.99	3.19	3.96
Ti	3.22	10.97	8.46	12.55	15.79	9.87	13.48	10.29	7.01
Mn	1037.37	1103.37	1134.61	1293.73	1290.95	1328.02	1276.19	1267.4	1328.65
Fe	8669.24	8699.16	8528.01	9141.51	9084.02	9232.4	9085.98	9109.73	9722.86
Y	71.13	64.08	60.7	70.34	76.23	86.86	90.86	83.94	69.27
Zr	0.27	0.3	0.27	0.27	0.28	0.26	0.21	0.29	0.38
La	<0.00	0.0081	0.0047	0.0023	0.0059	0.0045	0.0037	0.0052	<0.00
Ce	0.0066	0.0086	0.0047	0.0052	0.0032	0.0026	0.006	0.004	0.0061
Pr	0.0035	0.0042	0.0034	0.0047	0.0038	0.0038	0.0017	0.0021	0.0044
Nd	0.05	0.053	0.066	0.044	0.064	0.05	0.046	0.033	0.057
Sm	0.13	0.15	0.11	0.12	0.14	0.11	0.09	0.09	0.13
Eu	0.038	0.047	0.044	0.036	0.053	0.038	0.029	0.036	0.043
Gd	0.83	0.87	0.79	0.72	0.75	0.62	0.52	0.55	0.79
Tb	0.39	0.4	0.36	0.34	0.36	0.29	0.26	0.27	0.35
Dy	7.07	6.76	6.03	6.09	6.19	6.13	5.93	5.87	6.35
Ho	3.15	2.56	2.35	2.52	2.66	3.08	3.27	3.07	2.54
Er	13.74	9.97	9.43	10.86	12.5	16.65	19.59	16.62	10.36
Tm	3.19	2.04	2.02	2.57	3.19	4.91	6.49	4.95	2.45
Yb	23.5	13.38	13.38	17.89	24.46	40.9	61.87	41.85	16.54
Lu	4.18	2.27	2.33	3.03	4.31	8.3	13.95	8.69	2.88
Hf	0.056	0.054	0.041	0.034	0.06	0.047	0.047	0.046	0.047

One Sigma Error

	22AG3_19	22AG3_20	22AG3_21	22AG3_22	22AG3_23	22AG3_24	22AG3_25	22AG3_25	22AG3_26
Na	6.01	6.87	16.24	4.91	5.42	5.33	4.65	4.65	4.75
Mg	736.73	790	798.05	876.11	850.97	932.88	945.59	945.59	1034.45
Al	3608.55	3663.82	3598.48	3767.51	3652.16	3739.1	3605.19	3605.19	3605.17
Si^{29}	8288.13	8760.81	8565.29	9082.89	8273.31	9022.97	8743.15	8743.15	7765.95
Si^{30}	10774.33	11350.77	11439.02	11790.27	11255.23	12358.36	12131.9	12131.9	8335.77
P	19.25	18.25	22.22	18	22.97	30.15	26.07	26.07	22.5
Ca^{43}	781.96	787.17	713.53	560.47	522.46	507.27	491.53	491.53	380.59
Ca^{44}	556.49	544.84	486.43	373.2	334.26	325.55	312.12	312.12	345.88
Sc	4.54	4.59	5.07	8.54	7.19	6.13	7.28	7.28	6.27
Ti	16.79	9.33	6.83	1.67	2.15	2.85	3.55	3.55	3.12
Mn	1206.66	1233.35	1134.16	1077.85	928.56	911.74	779.42	779.42	631
Fe	9440	9988.97	10100.43	10889.66	10549.89	11271.08	11191.25	11191.25	6701.64
Y	60.75	60.11	75.27	26.45	28.38	38.8	27.41	27.41	23.26
Zr	0.35	0.28	0.28	0.22	0.3	0.31	0.4	0.4	0.27
La	0.0026	<0.00	0.0016	<0.00	0.0039	0.0019	<0.00	<0.00	0.0026
Ce	0.0045	0.0059	0.0021	0.0065	0.0026	0.0061	0.0042	0.0042	0.0042
Pr	0.0025	0.0037	0.0026	<0.00	0.0022	0.0053	0.0055	0.0055	0.0044
Nd	0.05	0.059	0.035	0.037	0.049	0.037	0.031	0.031	0.043
Sm	0.13	0.13	0.11	0.058	0.088	0.093	0.088	0.088	0.079
Eu	0.042	0.044	0.037	0.019	0.026	0.024	0.017	0.017	0.021
Gd	0.8	0.87	0.84	0.34	0.47	0.58	0.46	0.46	0.47
Tb	0.36	0.37	0.4	0.15	0.21	0.25	0.2	0.2	0.21
Dy	6.04	6.28	7.48	3.02	3.6	4.56	3.62	3.62	3.16
Ho	2.26	2.37	2.99	1.42	1.29	1.7	1.34	1.34	0.97
Er	8.32	8.61	11.74	6.3	4.07	5.7	4.35	4.35	2.89
Tm	1.8	1.88	2.78	1.61	0.8	1.18	0.82	0.82	0.43
Yb	11.15	11.46	18.51	11.2	4.08	6.57	4.15	4.15	2.19
Lu	1.81	1.96	3.28	2.32	0.56	1.01	0.7	0.7	0.31
Hf	0.036	0.048	0.035	0.03	0.036	0.04	0.031	0.031	0.03

One Sigma Error

	22AG3_27	22AG3_28	22AG3_29
Na	4.36	4.42	4.3
Mg	1055.16	1133.09	1144.56
Al	3605.16	3695.54	3695.55
Si^{29}	7770.83	7954.89	8095.15
Si^{30}	9144.8	9030.24	8920.74
P	32.9	29.6	30.83
Ca^{43}	390.79	393.46	409.45
Ca^{44}	350.71	363.68	367.16
Sc	6.64	6.73	6.88
Ti	3.07	3.17	2.42
Mn	504.58	409.53	294.21
Fe	6813.66	7051	7046.4
Y	16.33	13.34	6.67
Zr	0.3	0.36	0.33
La	0.008	0.0029	<0.00
Ce	0.0059	0.0014	0.0026
Pr	0.0054	0.002	0.004
Nd	0.028	0.052	0.044
Sm	0.085	0.078	0.066
Eu	0.023	0.025	0.021
Gd	0.48	0.52	0.38
Tb	0.19	0.2	0.13
Dy	2.57	2.4	1.35
Ho	0.69	0.58	0.3
Er	1.81	1.36	0.73
Tm	0.25	0.19	0.098
Yb	1.2	0.91	0.49
Lu	0.18	0.14	0.092
Hf	0.029	0.035	0.028

TABLE 4F LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	36_G1	36_G1_02	36_G1_03	36_G1_04	36_G1_05	36_G1_06	36_G1_07	36_G1_08	36_G1_09
Distance across:	40.76	116.74	171.95	230.8	283.14	334.12	391.41	447.7	504.29
Element:									
Na	116.03	56.7	51.73	62.58	55.64	48.54	51.72	50.57	106.77
Mg	15051.56	11661.4	9559.75	8932.6	8814.17	9578.84	9873.45	11246.01	14222.15
Al	116064.62	116223.39	113524.22	110983.81	112254.01	115799.98	111936.47	112889.12	112254.02
Si^{29}	175295.69	174472.89	170270.16	167457.92	171937.78	176290.22	171291.34	168222.48	164726.13
Si^{30}	178788.34	177137.91	175085.44	168599.98	172806.7	173629.77	170374.5	171034.89	165965.31
P	65.18	61.75	76.31	75.69	64.52	59.59	68.2	49.05	56.19
Ca^{43}	22377.23	25301.26	24240.82	23012.68	23790.34	24983.62	24462.05	24660.1	22350.22
Ca^{44}	22929.37	25834.45	25127.11	23838.08	23819.56	26005.3	25355.53	25844.72	23243.9
Sc	144.38	217.39	327.67	341.96	350.14	348.6	267.73	196.18	135.91
Ti	285.26	452.87	549.89	540.31	549.33	562.07	524.88	422.13	268.14
Mn	16805.72	39475.7	56315.15	60105.88	60084.28	59050.84	46551.33	33253.59	14234.94
Fe	215913.45	209719.53	191271.88	180543.48	181171.2	191387.28	194325.31	204664.91	213889.69
Y	655.66	317.93	354.26	604.21	585.43	419.55	314.07	330.08	708.75
Zr	5.11	6.12	6.29	5.95	6.17	6.57	6.13	5.95	4.67
La	BDL	BDL	0.0052	0.0014	BDL	BDL	0.0054	BDL	BDL
Ce	0.0092	0.0144	BDL	0.0207	0.0296	BDL	0.0335	BDL	BDL
Pr	0.0058	0.0242	0.0167	0.0174	0.013	BDL	0.015	0.0103	0.0068
Nd	0.183	0.364	0.425	0.416	0.444	0.433	0.457	0.268	0.251
Sm	1.33	2.42	3.16	2.98	2.86	3.36	3.04	2.3	1.36
Eu	1.055	1.75	1.798	1.619	1.824	1.913	1.981	1.611	1.156
Gd	18.31	25.98	25.67	25.9	26.88	28.45	26.11	23.88	18.99
Tb	8.03	8.18	8.94	10.8	10.77	9.79	8.32	7.91	8.69
Dy	92.11	62.8	70.3	104.69	103	80.59	62.29	61.69	98.8
Ho	23.02	10.87	12.54	21.07	20.42	14.76	11.4	11.57	25.74
Er	71.39	28.52	30.28	53.95	52.11	36.81	28.57	30.12	79.36
Tm	9.83	3.58	3.88	6.9	6.43	4.57	3.68	4	10.85
Yb	56.94	22.29	22.82	40.07	38.22	27.25	22.46	23.98	66.49
Lu	7.31	2.66	2.59	5.01	4.73	3.31	2.77	2.87	8.52
Hf	0.235	0.11	0.17	0.242	0.216	0.198	0.132	0.165	0.129

One Sigma Error									
Na	4.85	3.64	3.37	3.58	3.48	3.37	3.41	3.36	4.7
Mg	499.98	388.34	319.35	299.54	296.92	324.37	336.3	385.52	490.98
Al	3670.5	3675.53	3590.1	3509.74	3549.9	3662.05	3539.86	3569.98	3549.91
Si^{29}	7365.39	7344.27	7181.33	7079.99	7290.22	7499.43	7312.83	7210.17	7091.11
Si^{30}	10724.22	10754.65	10781.98	10564.71	11040.36	11335.3	11386.23	11717.34	11675.67
P	15.41	15.17	16.68	16.52	15.06	14.46	15.52	12.93	14.09
Ca^{43}	731.62	824.13	778.93	735.65	759.4	800.99	782.72	789.02	720.58
Ca^{44}	707.32	795.55	772.57	733.47	733.12	799.42	779.81	794.51	716.91
Sc	4.63	6.95	10.42	10.89	11.17	11.16	8.6	6.33	4.42
Ti	10.49	16.29	19.43	19.09	19.51	20.17	18.97	15.46	10.1
Mn	646.56	1530.4	2204.39	2380.05	2411	2405.09	1927.27	1401.3	611.29
Fe	6815.44	6630.8	6058.94	5732.42	5768.23	6112.94	6228.6	6585.77	6912.57
Y	21.66	10.57	11.81	20.22	19.72	14.24	10.75	11.4	24.68
Zr	0.25	0.29	0.28	0.26	0.27	0.29	0.27	0.26	0.22
La	0.0058	0.0062	0.003	0.0014	0.0057	0.0043	0.0027	0.0052	0.0045
Ce	0.0046	0.0059	0.0063	0.0052	0.008	0.008	0.0076	0.0053	0.0053
Pr	0.0034	0.007	0.0057	0.0044	0.0048	0.0056	0.004	0.0033	0.0028
Nd	0.06	0.072	0.063	0.057	0.066	0.064	0.056	0.049	0.05
Sm	0.14	0.2	0.2	0.18	0.17	0.2	0.18	0.15	0.12
Eu	0.069	0.097	0.088	0.076	0.081	0.088	0.087	0.075	0.061
Gd	0.78	1.04	0.98	0.96	0.99	1.07	0.98	0.91	0.76
Tb	0.3	0.31	0.33	0.39	0.39	0.36	0.31	0.3	0.34
Dy	2.99	2.09	2.28	3.34	3.29	2.61	2.03	2.01	3.2
Ho	0.84	0.41	0.47	0.77	0.76	0.56	0.44	0.45	1
Er	2.64	1.12	1.16	2.03	1.98	1.44	1.14	1.21	3.18
Tm	0.37	0.15	0.16	0.26	0.25	0.19	0.15	0.17	0.43
Yb	2.03	0.88	0.86	1.43	1.38	1.02	0.85	0.91	2.44
Lu	0.28	0.12	0.11	0.19	0.18	0.14	0.11	0.12	0.33
Hf	0.045	0.034	0.03	0.033	0.034	0.033	0.031	0.029	0.032

TABLE 4G LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	46C_G3_01	46C_G3_02	46C_G3_03	46C_G3_04	46C_G3_05	46C_G3_06	46C_G3_07	46C_G3_08	46C_G3_09
Distance across:	47.11	128.95	196.7	270.73	347.47	398.71	487.07	542.98	614.71
Element:									
Na	50.41	45.86	52.94	27.33	37.57	56.55	52.87	54.23	52.46
Mg	24350.51	28112.69	30576.09	32698.12	31400.81	33692.6	31327.01	31421.13	29967.33
Al	111936.42	116223.35	115852.88	116805.53	114900.23	115270.7	115164.86	118022.8	111513.02
Si^{29}	178541.2	182690.45	178560.95	213826.61	193992.55	193638.86	182772.81	185502.84	174869.64
Si^{30}	176726.19	183796.11	184770.47	204871.06	188842.94	207061.47	190901.98	191535.47	175344.91
P	145.63	132.64	134.73	87.27	141.43	193.78	144.75	157.08	159
Ca^{43}	9238.08	9945.81	9937.64	9495.79	9410.09	8801.68	9104.64	9077.26	8838.48
Ca^{44}	8644.79	8852.81	9023.22	8454.79	8588.19	7969.11	8297.7	8493.62	8110.26
Sc	169.96	173.6	149.49	139.27	131.75	123.69	132.99	114.35	107.15
Ti	215.54	83.42	104.66	56.47	111.88	95.34	189.18	184.78	190.26
Mn	27359.61	23036.3	19946.22	22543.81	20771.21	22388.19	20440.47	21158.93	19825.18
Fe	211238.05	215012.48	213360.05	230029.22	214824.56	223235.77	213797.52	218765.61	207269.14
Y	381.87	406.94	495.01	202.78	261.94	231.72	312.92	322.19	236.51
Zr	5.77	8.46	10.49	2.61	12.47	9.86	13.17	14.73	14.34
La	0.0041	BDL	BDL	BDL	BDL	0.0111	BDL	0.0052	BDL
Ce	0.0095	BDL	0.0102	0.0057	0.0102	BDL	0.0138	BDL	BDL
Pr	0.0081	BDL	0.013	0.0073	0.0099	BDL	0.0076	0.0177	0.0076
Nd	0.193	0.133	0.307	0.128	0.158	0.251	0.262	0.381	0.365
Sm	0.85	1.199	1.33	1.03	1.45	1.66	1.86	2.56	2.75
Eu	0.033	0.061	0.131	0.047	0.139	0.114	0.16	0.244	0.166
Gd	8.08	9.81	13.75	5.89	13.05	12.38	15.06	18.18	15.28
Tb	3.78	4.55	5.9	2.53	4.55	4.3	5.36	5.82	4.91
Dy	48.39	53.03	67.68	27.39	42.5	37.66	49.65	51.58	36.88
Ho	14.63	15.63	18.85	6.99	9.14	7.59	11.59	10.75	8.75
Er	54.54	57.63	63.28	24.39	27.4	21.62	37.54	33.53	25.64
Tm	9.2	9.17	9.49	3.96	4.17	3.08	5.64	5.02	3.57
Yb	63.8	66.48	65.41	27.97	28.92	21.02	40.72	35.21	27.1
Lu	9.48	9.95	9.46	3.71	3.9	2.46	5.65	4.37	3.45
Hf	0.154	0.237	0.301	0.096	0.26	0.139	0.253	0.328	0.225

TABLE 4G LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	46C_G3_10	46C_G3_11	46C_G3_12	46C_G3_13	46C_G3_14	46C_G3_15	46C_G3_16	46C_G3_17	46C_G3_18
Distance across:	689.74	760.28	840.69	916.24	989.12	1060.08	1137.57	1219.97	1287.29
Element:									
Na	57.68	53.61	54.82	43.22	40.03	42.63	40.65	42	41.55
Mg	34209.55	32706.72	33643.48	34172.48	31081.93	31017.83	34745.63	33808.24	34030.21
Al	117811.11	117493.56	117440.71	110930.92	115641.26	114794.44	115905.88	118605.04	117017.3
Si^{29}	199762.31	188920.19	202792.02	188876.03	185860.59	188545.53	195753.31	194063.58	217029.27
Si^{30}	192026.28	193318.38	208550.41	203916.89	185563.92	186607	198714.44	210513.31	209654.3
P	159.35	388.53	185.7	202.62	201.25	155.41	145.07	125.95	149.14
Ca^{43}	9518.03	9556.13	8774.04	8915.99	9034.2	9398.7	9387.8	9063.9	9143.23
Ca^{44}	8501.24	8838.07	8301.16	8077.86	8119.48	8664.72	8288.58	8031.37	8397.59
Sc	106.14	106.43	107.91	107.37	108.89	99.93	101.77	114.99	115.67
Ti	159.61	271.96	344.61	29620.95	241.5	194.85	25875.13	164.27	94.66
Mn	23997.9	23240.05	24114.3	23280.23	21313.32	20815.04	23561.56	22697.79	23426.27
Fe	230836.34	225955.23	234871.14	273670.5	205070.67	210989.81	249728.61	223204.98	232027.58
Y	225.04	217.69	238.87	256.56	279.35	213.54	282.78	212.66	202.97
Zr	10.83	14.44	13.23	16.3	21.54	15.75	12.17	18.95	13.04
La	0.816	0.231	0.181	0.188	0.025	0.025	0.028	BDL	0.026
Ce	1.596	0.713	0.383	0.655	0.091	0.121	0.132	0.023	0.135
Pr	0.246	0.116	0.062	0.058	0.0134	0.0171	0.0164	0.0197	0.031
Nd	1.08	0.916	0.59	0.29	0.49	0.65	0.152	0.212	0.288
Sm	2.56	2.56	1.37	1.95	1.8	2.9	1.91	1.25	1.32
Eu	0.229	0.264	0.26	0.237	0.232	0.217	0.157	0.176	0.098
Gd	13.71	14.56	12.24	12.96	14.23	16.83	11.8	9.64	8.97
Tb	4.18	4.54	3.85	4.45	4.83	5.11	4.52	3.42	3.22
Dy	35.92	35.25	36.96	38.56	42.95	37.38	42.08	33.63	31.14
Ho	8.23	7.64	9.14	9.96	10.29	7.11	9.83	7.94	7.13
Er	24.66	22.62	32.51	34.02	35.83	20.16	32.19	26.7	22.68
Tm	3.55	3.58	5.24	5.49	5.91	3.21	5.01	4.37	3.34
Yb	25.86	24.5	41.46	44.26	44.84	22.41	37.36	29.45	24.19
Lu	3.59	3.23	5.76	6.77	6.42	2.75	4.91	4.3	2.82
Hf	0.272	0.267	0.306	0.367	0.513	0.515	0.314	0.455	0.442

TABLE 4G LA-ICP-MS GARNET ZONATION DATA

Sample analysis:	46C_G3_19	46C_G3_20	46C_G3_21	46C_G3_22	46C_G3_23	46C_G3_24	46C_G325B	46C_G326	46C_G327
Distance across:	1358.05	1425.58	1515.3	1585.12	1656.55	1732.76	1823.42	1910.45	1988.91
Element:									
Na	61.22	62.07	53.21	51.65	58.06	41.04	62.48	138.55	51.91
Mg	31713.48	31903.43	31617.54	33660.67	33083.15	29016.1	31808.05	25360.36	26618.35
Al	117811.16	116964.36	118446.26	118393.34	119822.31	118234.57	119716.46	113100.84	112095.26
Si^{29}	195234.16	184727.02	190510.47	198262.09	201392.28	188378.84	192053.41	337118.25	177413.03
Si^{30}	187644.83	192243.06	192693.75	203017.69	211359.66	191613.13	197924.66	340060.78	177304.33
P	186.82	134.08	141.97	162.95	146.87	110.45	117.84	155.16	102.53
Ca^{43}	9158.58	9578.89	9876.54	10089.61	9588.92	9720.15	10003.56	9869.47	9688.32
Ca^{44}	8486.89	8840.98	8817.79	8802.88	9039.32	8966.06	8999.03	9422.56	8475.49
Sc	134.38	158.45	168.15	168.69	174.34	204.2	203.14	221.98	179.3
Ti	258.28	167.66	134.36	122.75	97.77	73.23	157.73	118.97	88.05
Mn	20986.39	20565.16	21034.71	21400.44	23302.24	21753.05	20879.11	22059.76	21001.5
Fe	214453.98	215436.34	222356.88	228975.53	237105.39	223653.91	223582.81	203841.25	207852.14
Y	635.07	518.19	481.34	462.95	363.86	328.51	398.05	522.62	462.99
Zr	12.15	12.16	11.63	12.81	13.24	5.52	8.67	7.23	6.82
La	0.096	BDL	0.0112	BDL	0.0109	BDL	BDL	0.022	0.00093
Ce	0.306	0.0664	0.0271	0.0276	BDL	0.0144	0.0057	0.055	BDL
Pr	0.0462	0.0159	0.0088	BDL	BDL	0.0043	BDL	BDL	BDL
Nd	0.454	0.218	0.255	0.281	0.142	0.16	0.181	4.88	0.174
Sm	1.79	1.452	1.42	1.62	1.11	0.738	1.083	1.37	1.107
Eu	0.124	0.124	0.119	0.158	0.148	0.0427	0.054	0.065	0.08
Gd	16.12	14.99	13.68	14.45	10.99	7.13	9.12	11.74	10.88
Tb	7.02	6.17	5.88	5.76	4.1	3.3	4.33	5.53	5.13
Dy	82.68	69.94	65.14	64.29	51.55	39.74	51.97	70.2	62.04
Ho	25.99	20.58	19.05	18.08	14.1	12.52	16.04	20.39	18.41
Er	105.29	80.27	75.45	67.33	56.29	49.98	62.6	75.32	66.54
Tm	18.18	13.97	12.86	10.99	9.17	8.62	9.92	12.25	10.61
Yb	141.24	109.54	103.89	83.94	71.75	67.1	74.77	84.03	76.37
Lu	22.55	17.69	16.68	13	11.12	10.64	11.77	12.97	11.1
Hf	0.229	0.233	0.307	0.231	0.418	0.205	0.24	0.175	0.185

One Sigma Error									
Na	2.89	2.89	3.39	3.07	2.74	3.18	2.98	3.15	3.77
Mg	853.72	991.17	1084.55	1167.05	1127.9	1218.39	1140.64	1152.25	1107.21
Al	3539.93	3675.38	3663.83	3693.99	3633.56	3645.38	3641.91	3732.3	3526.79
Si^{29}	8274.71	8518.53	8384.63	10109.1	9233.6	9286.89	8830.24	9032.59	8590.37
Si^{30}	7332.35	7639.74	7714.21	8566.95	7905.8	8692.53	8033.21	8086.06	7461.1
P	28.49	26.2	27.26	19.27	27.89	37.71	28.59	31.03	32.6
Ca^{43}	341.38	349.33	376.51	368.47	338.04	335.38	328.32	331.82	375.6
Ca^{44}	301.83	309.83	321.32	304.41	305.53	288.31	298.95	308.65	305.86
Sc	5.27	5.35	4.67	4.37	4.08	3.86	4.11	3.55	3.43
Ti	8.03	3.15	4.42	2.8	4.25	4.01	6.98	6.92	8.22
Mn	1040.71	884.3	773.05	882.36	821.22	894.46	825.39	863.8	818.53
Fe	8249.57	8483.38	8510.93	9278.69	8763.73	9215.92	8932.54	9254	8882.33
Y	12.66	13.52	16.54	6.84	8.82	7.87	10.64	11.01	8.2
Zr	0.25	0.3	0.42	0.16	0.44	0.39	0.46	0.51	0.62
La	0.0029	0.0039	0.0053	0.0083	0.0039	0.005	0.0044	0.0023	0.0047
Ce	0.0051	0.0036	0.0061	0.0041	0.0043	0.007	0.0034	0.0055	0.005
Pr	0.0043	0.0035	0.0067	0.0042	0.0029	0.004	0.0023	0.0053	0.0054
Nd	0.052	0.032	0.066	0.055	0.05	0.056	0.037	0.053	0.096
Sm	0.11	0.088	0.16	0.14	0.11	0.16	0.12	0.15	0.29
Eu	0.012	0.01	0.024	0.016	0.015	0.02	0.015	0.021	0.035
Gd	0.4	0.38	0.64	0.37	0.5	0.56	0.56	0.68	0.81
Tb	0.14	0.16	0.22	0.11	0.16	0.16	0.18	0.2	0.21
Dy	1.72	1.82	2.41	1.07	1.5	1.39	1.75	1.83	1.5
Ho	0.51	0.53	0.66	0.27	0.32	0.28	0.4	0.38	0.35
Er	1.78	1.83	2.09	0.88	0.9	0.77	1.22	1.1	0.99
Tm	0.34	0.33	0.37	0.17	0.16	0.13	0.21	0.19	0.18
Yb	2.28	2.32	2.4	1.12	1.06	0.85	1.48	1.3	1.2
Lu	0.32	0.32	0.33	0.15	0.14	0.1	0.19	0.15	0.16
Hf	0.034	0.026	0.05	0.034	0.031	0.035	0.031	0.035	0.059

One Sigma Error									
Na	3.46	3.02	3.54	3.83	3.53	3.4	3.8	3.14	3.73
Mg	1273.36	1226.78	1224.62	1247.25	1138.19	1140.39	1283.59	1255.54	1271.57
Al	3725.76	3715.59	3714.13	3508.47	3657.28	3630.43	3665.79	3750.83	3700.88
Si^{29}	9888.66	9428.46	9383.47	8765.08	8647.64	8801.69	9179.72	9136.01	10275.08
Si^{30}	8165.09	8229.52	9309.02	9130.53	8316.55	8367.97	8940.53	9458.61	9467.51
P	32.01	74.51	36.83	40.72	40.14	31.62	30.57	25.96	31.14
Ca^{43}	374.22	358.12	329.73	364.2	347.32	347.89	379.35	320.97	364.77
Ca^{44}	315.97	325.86	288.6	288.04	286.14	301.85	296.4	280.1	300.13
Sc	3.35	3.31	3.5	3.55	3.56	3.26	3.38	3.7	3.81
Ti	6.58	10.32	12.45	970.78	9.27	7.49	853	6.16	4.59
Mn	1002.06	981.65	761.31	735.51	673.86	658.73	746.57	720.06	744.38
Fe	10017.95	9933.93	8627.58	10082.55	7582.08	7834.07	9321.68	8377.57	8768.63
Y	7.81	7.57	8.06	8.71	9.47	7.26	9.66	7.26	7.01
Zr	0.44	0.52	0.53	0.69	0.81	0.6	0.55	0.66	0.56
La	0.054	0.019	0.026	0.034	0.012	0.01	0.015	0.0052	0.012
Ce	0.098	0.045	0.038	0.064	0.019	0.02	0.027	0.0083	0.026
Pr	0.025	0.012	0.014	0.017	0.0067	0.0074	0.0093	0.0066	0.013
Nd	0.12	0.086	0.11	0.1	0.1	0.11	0.068	0.058	0.095
Sm	0.22	0.17	0.18	0.26	0.22	0.26	0.26	0.14	0.2
Eu	0.032	0.024	0.038	0.045	0.039	0.034	0.037	0.025	0.027
Gd	0.64	0.58	0.63	0.76	0.73	0.77	0.72	0.46	0.58
Tb	0.17	0.16	0.16	0.2	0.2	0.2	0.2	0.13	0.16
Dy	1.38	1.3	1.32	1.47	1.54	1.33	1.59	1.15	1.22
Ho	0.31	0.28	0.34	0.39	0.38	0.27	0.38	0.28	0.29
Er	0.89	0.77	1.15	1.27	1.27	0.75	1.22	0.92	0.9
Tm	0.16	0.15	0.2	0.23	0.23	0.14	0.22	0.16	0.16
Yb	1.07	0.96	1.48	1.68	1.62	0.88	1.47	1.04	1.02
Lu	0.15	0.12	0.23	0.28	0.25	0.13	0.22	0.16	0.14
Hf	0.05	0.035	0.059	0.083	0.083	0.075	0.076	0.06	0.085

One Sigma Error									
Na	3.3	3.29	3.09	3.29	3.83	2.97	3.46	8.46	3.05
Mg	1192.73	1208.58	1207.16	1296	1285.21	1137.71	1272.47	1025.56	1088.19
Al	3725.62	3698.81	3745.68	3744.1	3789.44	3738.99	3785.86	3576.99	3544.85
Si^{29}	9289.23	8843.59	9181.6	9625.69	9855.49	9288.47	9634.87	17074.95	9068.79
Si^{30}	8475.38	8708.25	8759.46	9269.96	9703.92	8823.35	9202.98	15958.82	8335.23
P	36.66	26.96	28.35	32.65	30.45	22.89	24.3	37.35	21.33
Ca^{43}	306.56	316.12	325.96	349.45	359.98	324.02	336.14	393.36	325.19
Ca^{44}	293.87	306.09	306.47	309.89	323.88	316.72	321.64	379.8	306.16
Sc	4.3	5.06	5.37	5.43	5.67	6.56	6.56	7.3	5.82
Ti	8.95	5.86	4.77	4.72	4.35	2.77	5.72	5.46	3.34
Mn	667.87	655.67	672	685.22	747.93	699.9	675.5	715.96	683.64
Fe	8159.66	8261.47	8599.41	8936.83	9344.85	8901.83	9093.24	8388.81	8651.81
Y	21.76	17.84	16.66	16.14	12.8	11.59	14.24	18.89	16.81
Zr	0.41	0.4	0.39	0.46	0.53	0.2	0.3	0.36	0.24
La	0.011	0.006	0.0031	0.0041	0.0063	0.0045	0.0034	0.013	0.00093
Ce	0.021	0.0085	0.0067	0.0077	0.0085	0.0035	0.0023	0.017	0.0036
Pr	0.007	0.0041	0.0034	0.0048	0.0045	0.0018	0.0043	0.012	0.003
Nd	0.057	0.036	0.036	0.056	0.053	0.031	0.034	0.37	0.034
Sm	0.12	0.098	0.099	0.15	0.16	0.071	0.09	0.2	0.089
Eu	0.015	0.013	0.013	0.022	0.028	0.0077	0.01	0.027	0.011
Gd	0.6	0.54	0.5	0.6	0.59	0.3	0.37	0.67	0.42
Tb	0.24	0.21	0.2	0.21	0.17	0.12	0.15	0.23	0.18
Dy	2.61	2.2	2.06	2.09	1.78	1.28	1.67	2.43	1.98
Ho	0.85	0.67	0.63	0.61	0.5	0.42	0.54	0.73	0.62
Er	3.31	2.53	2.38	2.17	1.9	1.6	2	2.55	2.13
Tm	0.57	0.44	0.4	0.36	0.33	0.28	0.32	0.44	0.34
Yb	4.45	3.45	3.28	2.73	2.45	2.15	2.4	2.91	2.46
Lu	0.73	0.57	0.54	0.44	0.4	0.35	0.39	0.48	0.37
Hf	0.029	0.03	0.036	0.038	0.07	0.026	0.033	0.06	0.026

TABLE 4H LA-ICP-MS NIST 610 STANDARDS

Sample analysis:	610_01	610_02	610_03	610_04	610_05	610_06	610_07	610_08	610_09
Element:		ANALYSIS DAY ONE APRIL 24TH 2019					ANALYSIS DAY ONE APRIL 24TH 201		
Na	99590	99236.27	100494.44	98386.27	99673.63	99161.81	99616.23	99267.2	99030.64
Mg	475.38	454.76	476.38	454.14	469.53	460.4	465.92	464.51	452.75
Al	10320.01	10320.01	10320.01	10320.01	10320.01	10320.01	10320.01	10320.01	10320.01
Si^{29}	328147.16	323318.97	333100.59	319163.38	328456.44	323496.34	321212.25	330795.22	323838.16
Si^{30}	324479.84	327176.75	339486.47	309907	318389.16	333388.84	322277.88	330532.97	323310.34
P	430.73	394.46	399.99	427.88	428.52	398.24	400.51	427.66	429.79
Ca^{43}	82776.24	80167.38	83956.42	79168.3	82475.46	80545.38	81786	81225.16	79942.61
Ca^{44}	82459.41	80437.91	83456.14	79577.84	80950.34	82007.35	82103.7	80902.71	80268.72
Sc	455.35	454.44	462.59	447.69	458.44	451.72	452.32	457.55	456.88
Ti	460.25	443.78	464.91	439.89	456.03	448.31	445.12	458.94	458.15
Mn	447.01	441.11	451.11	437.26	441.34	446.72	443.01	445.1	440.07
Fe	462.03	453.9	469.56	446.26	469.78	446.28	456.65	459.25	461.99
Y	465.9	458.21	461.1	462.78	461.44	462.8	454.16	469.74	464.09
Zr	452.44	443.59	450.6	445.61	441.26	455.45	437.57	458.46	451.19
La	445.07	434.93	445.98	434.28	440.59	439.68	433	447.03	439.15
Ce	459.09	447.06	461.37	445.44	447.04	459.24	449.52	456.45	451.7
Pr	453.95	441.97	464.53	433.17	447.23	448.83	447.68	448.37	445.36
Nd	433.05	426.8	436.89	423.49	430.49	429.8	418.29	441.99	430.1
Sm	455.38	450.6	457.88	448.46	452.79	453.3	449.55	456.32	453.98
Eu	450.26	443.61	455.68	438.94	449.3	445.03	438.77	455.34	444.87
Gd	451.75	446.18	453.96	444.27	447.84	450.46	441.17	456.96	445.53
Tb	441.31	432.63	443.84	430.45	438.85	435.32	431.73	442.26	436.1
Dy	442.22	431.72	442.64	431.62	434.75	439.52	429.75	444.42	432.4
Ho	452.28	445.66	450.5	447.58	446.24	452.05	441.05	456.89	451.68
Er	456.16	453.76	463.2	447.3	451.95	458.21	450.17	459.68	456.77
Tm	437.21	432.76	435.76	434.31	432.48	437.85	426.4	443.72	432.61
Yb	458.92	441.55	452.33	447.75	448.69	451.52	444.08	455.9	449.25
Lu	444	433.92	443.87	434.29	437.09	441.25	429.65	448.42	439.76
Hf	435.74	434.17	437.95	431.94	438.95	431.37	428.4	441.53	435.35

TABLE 4H LA-ICP-MS NIST 610 STANDARDS

Sample analysis:	610_10	610_11	610_12	610_01	610_02	610_03	610_04	610_05	610_06
Element:				ANALYSIS DAY TWO MAY 4TH 2019					
Na	99656.35	100714.84	97988.14	98515.65	100024.92	100032.26	98708.69	98428.38	100594.26
Mg	476.98	465.94	462.57	459.04	469.12	466.68	462.87	459.62	470.97
Al	10320.01	10320.01	10320.01	10320.01	10320.01	10320.01	10320.01	10320	10320
Si^{29}	327365.94	329583.09	321556	322065.81	328576.94	325006.31	326546.97	323354.69	328518.75
Si^{30}	328157.88	324332.59	327321.41	312222.53	336267.91	317800.41	331923.22	315947.31	334185.16
P	399.1	410.4	417.68	411.31	414.21	413.78	412.28	402.74	422.01
Ca^{43}	82949.66	81739.12	81006.71	81211.49	81674.8	81146.63	81827.38	81206.02	81746.3
Ca^{44}	82704.62	80689.64	82244.42	81487.71	81474.83	81299.32	81637.41	81247.91	81687.59
Sc	453.69	450.49	460.41	458.47	452.54	456.79	453.29	454.18	455.94
Ti	447.61	439.25	468.12	444.55	457.23	453.01	450.52	446.17	458.62
Mn	447.75	443.69	443.92	437.72	448.82	435.87	452.93	439.89	448.65
Fe	454.13	451.21	465.95	461.99	454.92	458.77	457.39	455.53	461.1
Y	460.28	459.7	464.86	468.92	457.38	461.93	462.42	461.03	463.09
Zr	445.27	445.71	450.96	457.38	441.68	450.38	445.88	447.01	449.19
La	441.01	437.84	442.37	444.62	436.97	438.19	442.24	438.6	441.53
Ce	454.52	449.95	456.34	454.36	452.19	450.49	455.86	448.01	458.67
Pr	450.58	447.21	448.6	448.83	447.5	446.55	449.64	448.83	447.2
Nd	430.26	426.34	434.22	431.25	429.32	426.11	434.42	431.06	428.9
Sm	452.03	453.62	452.41	456.6	450.61	451.89	454.4	452.68	453.34
Eu	449.13	445.79	448.13	448.81	445.82	445.86	448.34	446.93	447.1
Gd	452.1	451.08	446.29	454.63	445.12	451.06	447.05	449.71	448.33
Tb	437.92	436.24	437.76	444.86	431.83	436.03	438.45	437.72	436.18
Dy	441.81	432.94	441.13	440.44	434.64	437.64	436.48	440.72	432.97
Ho	446.86	445.37	453.47	458.01	442.97	450.46	447.85	447.76	450.5
Er	453.53	453.14	457.32	464.99	448.43	454.23	456.34	456.5	453.37
Tm	437.54	432.31	437.8	444.06	429.03	434.64	435.84	433.79	436.37
Yb	451.06	446.33	454.12	455.95	446.16	446.44	454.28	452.61	447.07
Lu	438.54	436.37	442.1	447.01	433.67	439.19	439.19	435.87	442.58
Hf	434.82	433.48	436.76	443.21	429.54	434.89	435.53	432.22	438.17

TABLE 4H LA-ICP-MS NIST 610 STANDARDS

Sample analysis:	610_07	610_08	610_09	610_10
Element:	ANALYSIS DAY TWO MAY 4TH 2019			
Na	99113.66	99685.72	100220.02	98551.71
Mg	464.79	465.07	463.19	467.37
Al	10320	10320	10320.01	10320.01
Si^{29}	322560.19	329216	329922.38	321222.53
Si^{30}	325681.97	325829.44	324226.28	328291.81
P	405.24	420.45	404.78	422.63
Ca^{43}	81702.17	81244.83	81731.96	81187.85
Ca^{44}	81302.31	81635.96	80895.09	82188.66
Sc	451.2	458.72	452.69	457.33
Ti	449.33	454.5	454.5	448.98
Mn	449.46	438.51	444.2	444.24
Fe	457.82	458.03	458.43	457.81
Y	459.11	464.93	458.84	465.26
Zr	449.08	446.85	447.39	448.64
La	438.86	441.17	443.97	435.62
Ce	452.89	453.2	458.36	447.31
Pr	446.47	449.77	448.85	447.06
Nd	426.86	433.38	430.92	428.59
Sm	454.91	451.07	455.6	450.35
Eu	446.42	447.59	451.51	442.15
Gd	449.18	449	448.34	449.71
Tb	436.06	437.98	433.76	440.56
Dy	433.25	441.02	436.57	437.15
Ho	445.24	452.91	448.76	448.95
Er	450.6	459.55	454.4	455.37
Tm	433.14	436.94	434.11	435.85
Yb	448.95	451.16	449.53	450.55
Lu	435.15	442.87	441.7	435.79
Hf	434.04	435.9	434.07	435.86

One Sigma Error									
Na	3058.37	3047.49	3284.2	3215.45	3061.35	3045.59	3291.42	3280.91	3343.22
Mg	20.4	19.53	19.24	18.35	15.99	15.68	18.49	18.45	19.03
Al	326.58	326.57	326.66	326.64	326.62	326.61	326.63	326.61	326.64
Si29	15173.2	14977.58	16922.82	16231.65	15237.4	15006.75	14579.14	15022.81	14467.58
Si30	13631.21	13755.87	21741.61	19915.09	16646.88	17420.22	14791.69	15185.8	14106.29
P	87.18	80.45	82.14	88.26	103.05	95.83	91.82	98.14	95.78
Ca43	3246.27	3145.86	3663.4	3455.66	3045.54	2974.42	2876.58	2855.22	2968.12
Ca44	3271.26	3194.11	3262.96	3112.45	2524.71	2557.38	2917.9	2877.14	2860.61
Sc	15.3	15.27	16.52	15.99	14.8	14.59	14.35	14.51	15.08
Ti	19.16	18.48	20.72	19.62	17.25	16.94	16.46	16.88	22.02
Mn	14.23	14.04	15.63	15.15	13.89	14.06	14.1	14.16	14.11
Fe	17.77	17.44	23.25	22.27	21.73	20.82	17.92	17.93	19.78
Y	14.72	14.48	14.29	14.34	15.54	15.58	16.25	16.81	14.49
Zr	14.75	14.46	14.31	14.15	20.64	21.3	17.36	18.19	14.38
La	15.09	14.74	14.86	14.47	15.32	15.29	14.89	15.37	13.53
Ce	15.29	14.89	18.13	17.5	15.2	15.62	14.05	14.27	14.1
Pr	17.23	16.77	21.83	20.37	13.63	13.67	13.63	13.65	13.74
Nd	14.89	14.67	15.1	14.63	15.45	15.42	17.38	18.35	13.76
Sm	14.26	14.1	15.27	14.94	14.15	14.16	14.33	14.53	13.99
Eu	15.19	14.96	16.44	15.84	16.19	16.04	15.7	16.29	13.69
Gd	14.49	14.31	14.83	14.5	16.03	16.11	15.93	16.48	14.3
Tb	14.98	14.68	15.29	14.83	13.96	13.84	14.08	14.42	13.23
Dy	15.81	15.43	14.66	14.29	15.22	15.38	15.65	16.17	14.66
Ho	14.57	14.35	13.72	13.63	15.64	15.84	15.85	16.42	14.47
Er	14.12	14.04	16.34	15.78	14.54	14.74	14.72	15.02	14.14
Tm	13.52	13.38	13.27	13.22	15.76	15.96	15.51	16.14	13.6
Yb	16.83	16.19	14.01	13.86	14.91	15	14.79	15.17	14.27
Lu	15.86	15.5	14.39	14.07	16.23	16.38	16.16	16.86	13.6
Hf	13.57	13.52	14.72	14.51	15.44	15.18	14.7	15.14	13.34

One Sigma Error									
Na	3370.73	3945.33	3941.91	3172.53	3221.35	3509.39	3493.85	3813.25	3933.73
Mg	20.12	26.62	27.7	15.29	15.6	17.22	17.27	17.81	18.42
Al	326.6	326.61	326.68	326.53	326.47	326.49	326.52	326.52	326.54
Si29	14643.21	16054.7	15921.25	13485.66	13765.22	14545.27	14713.66	14101.53	14367.02
Si30	14312.82	14906.71	15209.53	18385.74	19837.13	27335.63	29407.24	22526.92	24238.72
P	88.72	93.94	96.76	74.88	74.96	75.59	75.19	77.84	81.49
Ca43	3081.9	3824.09	3948.22	2543.55	2545.94	2600.94	2634.52	2802.74	2839.62
Ca44	2956.75	3577.55	3783.28	2485.08	2482.72	2489.89	2501.22	2504.25	2519.06
Sc	14.98	16.5	17.22	14.51	14.31	15.26	15.24	14.19	14.26
Ti	21.5	29.56	33.2	15.74	15.94	18.35	18.58	17.68	18.38
Mn	14.35	15.35	15.61	16.71	17.14	21.85	23.26	15.26	15.65
Fe	19.76	22.42	24.14	16.87	16.08	17.26	17.5	17.83	18.54
Y	14.37	15.04	15.37	15.42	15.04	17.56	17.85	14.12	14.19
Zr	14.19	15.26	15.68	16.26	15.71	20.17	20.4	14.21	14.31
La	13.58	13.92	14.16	14.16	13.91	15.44	15.75	13.55	13.66
Ce	14.19	14.89	15.29	14.03	13.95	14.52	14.77	16.05	16.56
Pr	13.9	14.36	14.53	13.65	13.6	13.81	13.94	14.36	14.35
Nd	13.74	14.66	15.19	13.78	13.67	14.98	15.45	13.53	13.5
Sm	13.89	14.05	14.1	14.34	14.09	15.04	15.25	13.9	13.95
Eu	13.82	14.17	14.36	13.71	13.6	13.94	14.06	13.55	13.57
Gd	14.48	15.55	15.65	14.85	14.5	16.83	16.94	14.48	14.49
Tb	13.27	13.33	13.41	15.05	14.62	18.07	18.54	13.32	13.28
Dy	14.98	17.05	17.86	13.74	13.52	14.4	14.47	14.87	14.69
Ho	14.33	15.69	16.27	15.9	15.4	19.82	20.15	14.52	14.66
Er	14.02	14.49	14.75	16.51	15.93	20.87	21.49	14.13	14.06
Tm	13.76	14.53	14.92	15.48	14.98	19.35	19.86	13.29	13.38
Yb	14.32	15.21	15.72	15.22	14.87	17.74	18.39	14.8	14.68
Lu	13.57	14.09	14.41	15.13	14.7	18.3	18.68	14.39	14.67
Hf	13.31	13.47	13.64	15.17	14.7	18.47	18.9	14.1	14.35

One Sigma Error

Na	3651.26	3699.89	3362.1	3326.57
Mg	16.11	16.2	17.48	17.86
Al	326.51	326.53	326.54	326.58
Si29	14944.31	15329.52	16018.08	15753.86
Si30	15747.19	15856.94	17623.64	18129.58
P	74.86	77.58	75.93	79.86
Ca43	2552.54	2541.7	2574.65	2567.4
Ca44	2602.14	2619.22	2676.76	2736.26
Sc	17.38	17.83	16.6	16.96
Ti	20.11	20.61	17	17.08
Mn	16.75	16.47	18.97	19.32
Fe	17.86	18.1	18.48	18.76
Y	15.27	15.53	17.28	17.74
Zr	13.96	13.91	13.75	13.81
La	13.45	13.53	15.24	15.07
Ce	14.28	14.32	17.12	16.92
Pr	16.27	16.51	13.65	13.6
Nd	15.03	15.36	17.37	17.57
Sm	14.31	14.22	15.83	15.81
Eu	13.55	13.59	15.87	15.69
Gd	16.18	16.29	13.82	13.9
Tb	13.31	13.37	14.61	14.94
Dy	15.42	15.8	16.13	16.35
Ho	15.02	15.35	16.28	16.47
Er	15.96	16.39	16.12	16.32
Tm	13.5	13.63	13.77	13.88
Yb	14.23	14.33	13.74	13.8
Lu	16.52	16.95	15.86	15.82
Hf	13.81	13.9	14.23	14.38

TABLE 4I LA-ICP-MS NIST 612 STANDARDS

Sample analysis:	612_01	612_02	612_03	612_04	612_05	612_01	612_02	612_03	612_04
Element:	ANALYSIS DAY ONE APRIL 24TH 2019					ANALYSIS DAY TWO MAY 4TH 2019			
Na	121249.66	102910.43	110754.78	104266.14	103519.4	103535.1	96988.21	126381.25	118738.33
Mg	70.58	63	59.95	61.64	66.8	63.88	58.96	70.33	65.39
Al	10743.78	10743.78	10743.78	10743.78	10743.78	10743.78	10743.79	10743.78	10743.78
Si29	431633.72	322217.84	336503.72	340532.69	325747.38	335259.03	346633.78	412841.75	376045.91
Si30	425616.75	324943.31	363363.56	314070.94	310070.66	322726.44	337876.66	431014.53	377623.31
P	70.9	107.32	102.02	113.73	149.15	56.67	55.27	51.05	43.34
Ca43	90862.27	83714.83	87765.14	83626.44	89106.39	83296.8	82843.52	88922.97	87820.96
Ca44	88880.29	82379.47	85424.59	83523.98	86163.16	85201.35	86393.59	86090.35	84424.54
Sc	44.18	42.44	42.59	44.17	42.2	41.46	38.56	38.61	39.57
Ti	39.75	45.37	39.61	43.45	43.53	41.85	40.87	44.46	39.89
Mn	43.55	38.55	39.33	95.56	39.65	38.62	38.06	44.36	41.97
Fe	197.52	152.31	142.75	119.09	126.56	105.38	86.26	89.67	85.17
Y	34.31	38.51	38.31	39.26	42.16	37.52	35.77	34.93	37.16
Zr	35.89	38.75	41.35	38.63	40.83	37.2	37	34.94	36.35
La	36.37	37.08	37.25	36.54	37.08	34.96	34.08	34.53	35.53
Ce	43.43	38.47	40.55	39.73	40.75	38.23	38.88	42.8	40.52
Pr	39.55	37.29	40.94	38.69	39.29	37.09	37.65	38.97	37.5
Nd	36.7	33.54	36.33	35.99	37.11	34.78	33.14	31.31	34.97
Sm	34.87	34.03	34.47	41.19	41.38	38.59	37.01	36.76	35.47
Eu	38	34.6	37.19	36.37	37.32	35.15	33.74	34.06	35.78
Gd	36	37.73	38.91	38.7	40.6	37.77	36.18	34.85	36.21
Tb	33.89	35.33	37.5	37.08	40.09	36.62	35.11	35.96	34.6
Dy	31.14	35.13	36.43	35.18	38.93	36.61	34.18	33.21	35.49
Ho	33.13	37	38.38	39.64	40.26	37.78	35.62	35.47	36.14
Er	34.93	39.29	38.37	38.52	41.95	37.42	36	34.82	38.27
Tm	33.87	36.93	37.72	37.58	39.69	36.47	36.27	34.93	35.08
Yb	35.62	38.57	39.87	39.93	41.43	38.32	36.75	35.72	36.83
Lu	34.02	37.14	38.05	36.69	38.21	37.15	35.57	33.33	35.01
Hf	32.98	37.42	36.98	37.39	42.75	37.2	35.65	34.94	35.66

One Sigma Error					One Sigma Error				
Na	3727.54	3366.5	3403.16	3449.94	3523.21	3337.72	3239.45	4150.45	3751.7
Mg	3.41	3.02	2.41	2.79	3.49	2.24	2.15	2.47	2.32
Al	340.62	340.46	340.28	340.3	340.72	340.02	340.14	340.2	340.09
Si29	20066.93	16432.63	15627.1	15493.34	14653.65	14066.75	14477.92	17738	16479.46
Si30	17910.11	21191.79	19153.48	14780.76	14360.52	19208.18	17465.44	18870.8	17431.43
P	27.11	41.92	43.47	48.58	57.47	21.92	23.14	19.35	18.71
Ca43	3675.27	3719.33	3287.18	2994.16	3463.44	2625.55	2697.5	2811	2758.14
Ca44	3545.46	3233.59	2669.68	2980.19	3121.18	2605.03	2648.95	2671.13	2651.28
Sc	1.75	1.76	1.57	1.61	1.77	1.54	1.49	1.51	1.5
Ti	3.51	3.64	2.84	3.05	4.27	2.4	2.58	2.8	2.33
Mn	1.64	1.62	1.44	3.23	1.75	1.55	1.34	1.59	1.56
Fe	13.63	15.21	13	12.92	19.16	7.19	7.75	7.66	7.2
Y	1.25	1.33	1.38	1.5	1.5	1.29	1.17	1.19	1.29
Zr	1.47	1.48	2.07	1.7	1.63	1.42	1.3	1.25	1.25
La	1.36	1.34	1.37	1.33	1.29	1.16	1.11	1.13	1.19
Ce	1.57	1.59	1.45	1.32	1.41	1.22	1.31	1.39	1.38
Pr	1.59	1.81	1.31	1.24	1.33	1.17	1.22	1.33	1.18
Nd	1.77	1.56	1.6	1.76	1.74	1.31	1.33	1.34	1.44
Sm	1.7	1.61	1.46	1.7	1.92	1.45	1.5	1.54	1.44
Eu	1.46	1.38	1.44	1.4	1.35	1.14	1.13	1.15	1.23
Gd	1.74	1.7	1.73	1.74	1.91	1.46	1.48	1.52	1.42
Tb	1.25	1.29	1.25	1.27	1.33	1.28	1.13	1.16	1.14
Dy	1.47	1.47	1.49	1.5	1.71	1.29	1.31	1.33	1.35
Ho	1.18	1.22	1.4	1.48	1.41	1.35	1.17	1.19	1.22
Er	1.39	1.61	1.42	1.44	1.62	1.44	1.29	1.32	1.38
Tm	1.16	1.21	1.43	1.42	1.36	1.31	1.16	1.14	1.13
Yb	1.69	1.54	1.57	1.58	1.75	1.44	1.4	1.39	1.34
Lu	1.32	1.29	1.47	1.44	1.3	1.3	1.17	1.17	1.18
Hf	1.37	1.52	1.49	1.48	1.67	1.4	1.32	1.31	1.28

All concentrations reported as parts per million
BDL= Below Detecton Limit

TABLE 5 X RAY FLUORESCENSE RAW BULK ROCK DATA

Sample Identification	191-03A	191-05A	191-08A	191-10a	191-11	191-17A
Unnormalized Bulk Rock Major Elements (weight percent):						
SiO2	68.264	65.706	71.920	54.780	67.371	59.796
TiO2	0.705	0.786	0.613	0.961	0.691	0.992
Al2O3	13.305	14.521	14.309	20.375	14.165	19.072
FeO*	5.803	5.958	4.710	7.078	5.206	7.314
MnO	0.096	0.082	0.086	0.082	0.087	0.092
MgO	2.556	2.968	2.027	3.013	2.483	3.510
CaO	3.015	3.880	1.165	4.415	2.402	1.779
Na2O	1.981	2.215	1.251	3.726	2.339	2.237
K2O	1.978	1.453	1.590	2.064	1.838	3.151
P2O5	0.186	0.194	0.109	0.243	0.148	0.094
Sum	97.888	97.763	97.781	96.737	96.728	98.038
LOI %	1.525	1.701	1.663	2.636	3.024	1.678
Total	99.413	99.464	99.445	99.373	99.752	99.716
Unnormalized Bulk Rock Trace Elements (weight percent):						
Ni	70.389	36.884	23.200	68.742	18.810	40.788
Cr	176.517	135.675	80.800	124.922	94.941	145.134
Sc	15.543	19.698	14.400	20.502	16.335	23.067
V	147.213	179.795	142.900	200.799	148.005	221.166
Ba	506.187	430.341	460.200	707.219	530.739	811.305
Rb	67.997	40.779	56.154	68.359	59.752	93.411
Sr	281.457	298.787	144.100	505.515	245.322	296.010
Zr	134.332	117.228	107.123	179.950	120.089	180.543
Y	18.018	22.814	18.800	23.316	17.523	23.859
Nb	7.128	6.432	7.900	12.060	6.237	11.286
Ga	14.256	15.477	18.400	21.608	15.642	21.681
Cu	75.834	66.330	14.800	57.084	23.463	30.690
Zn	100.881	98.691	182.000	124.821	102.960	147.510
Pb	11.385	8.643	10.600	18.693	10.890	13.266
La	13.167	13.970	17.500	29.045	11.781	27.918
Ce	38.115	33.869	38.800	62.712	24.156	56.331
Th	5.643	4.523	5.500	8.342	3.861	8.118
Nd	17.127	16.181	20.100	28.944	12.474	27.720
U	1.386	2.513	3.300	3.116	2.277	2.574
sum tr.	1702.575	1548.625	1366.577	2265.746	1465.257	2182.377
in %	0.170	0.155	0.137	0.227	0.147	0.218
sum m+tr	98.058	97.918	97.918	96.964	96.875	98.256
M+Toxides	98.100	97.957	97.950	97.015	96.909	98.306
w/LOI	99.625	99.658	99.614	99.652	99.933	99.984
if Fe3+	100.269	100.319	100.136	100.437	100.510	100.796

All bulk rock major and trace element data collected at the Peter Hooper Geoanalytical Lab at Washington State University January 2019

TABLE 5 X RAY FLUORESCENSE RAW BULK ROCK DATA

Sample Identification	191-17B	191-21A	191-22A	191-28A	191-30	191-34
Unnormalized Bulk Rock Major Elements (weight percent):						
SiO2	65.285	61.648	57.881	63.284	63.766	67.177
TiO2	0.744	0.791	1.047	0.814	0.849	0.721
Al2O3	15.594	17.703	20.459	16.311	16.796	15.019
FeO*	5.630	6.070	7.120	6.033	6.641	5.343
MnO	0.116	0.092	0.076	0.144	0.095	0.062
MgO	2.427	2.838	3.246	2.644	2.679	2.483
CaO	2.313	2.770	2.181	2.930	2.077	2.354
Na2O	2.803	2.919	2.310	2.480	1.995	2.184
K2O	1.986	2.293	2.635	2.136	1.957	1.888
P2O5	0.315	0.164	0.173	0.212	0.133	0.123
Sum	97.212	97.288	97.127	96.989	96.989	97.355
LOI %	2.410	1.927	2.331	2.538	2.394	2.275
Total	99.623	99.215	99.458	99.527	99.383	99.630
Unnormalized Bulk Rock Trace Elements (weight percent):						
Ni	36.432	33.936	31.356	23.980	43.880	40.293
Cr	101.574	103.323	147.333	96.018	104.973	97.119
Sc	18.612	19.089	22.311	19.801	20.199	17.919
V	164.043	172.912	214.467	167.359	171.638	153.945
Ba	654.786	628.725	883.496	602.771	568.145	540.342
Rb	69.064	77.913	82.445	72.540	74.393	56.260
Sr	195.723	373.902	303.812	286.162	272.929	267.696
Zr	136.996	145.617	208.035	150.972	148.913	117.322
Y	24.354	23.634	28.241	21.890	20.298	19.107
Nb	8.118	8.383	12.663	9.254	9.055	6.831
Ga	16.434	17.574	24.020	17.612	19.204	15.345
Cu	59.301	37.067	28.643	76.914	29.452	43.461
Zn	91.080	107.767	145.625	106.565	151.738	94.149
Pb	16.929	17.675	14.573	15.323	14.826	9.108
La	17.028	21.008	33.065	13.632	12.736	16.434
Ce	36.630	45.551	60.200	38.009	28.557	32.967
Th	5.148	6.565	8.643	6.468	5.672	2.871
Nd	20.196	23.432	29.949	18.109	12.935	16.929
U	1.980	2.727	2.613	2.587	2.388	1.485
sum tr.	1674.428	1866.800	2281.485	1745.962	1711.925	1549.583
in %	0.167	0.187	0.228	0.175	0.171	0.155
sum m+tr	97.380	97.475	97.355	97.163	97.160	97.510
M+Toxides	97.418	97.517	97.407	97.203	97.200	97.545
w/LOI	99.828	99.444	99.738	99.741	99.594	99.820
if Fe3+	100.453	100.118	100.529	100.411	100.331	100.414

TABLE 5 X RAY FLUORESCENSE RAW BULK ROCK DATA

Sample Identification	191-36	191-41	191-46B	191-46c	191-47B
Unnormalized Bulk Rock Major Elements (weight percent):					
SiO2	63.360	66.003	61.898	60.497	59.420
TiO2	0.839	0.789	0.834	0.859	0.940
Al2O3	18.139	15.469	16.973	17.129	18.474
FeO*	6.484	6.255	7.087	7.504	6.289
MnO	0.120	0.072	0.116	0.154	0.078
MgO	2.623	3.165	3.551	3.685	2.879
CaO	1.417	1.804	2.599	3.140	2.860
Na2O	1.491	1.352	2.245	2.688	3.396
K2O	2.534	1.809	1.973	2.403	2.154
P2O5	0.162	0.182	0.187	0.181	0.139
Sum	97.170	96.899	97.463	98.240	96.629
LOI %	2.408	2.426	1.961	1.268	2.289
Total	99.578	99.325	99.424	99.507	98.918
Unnormalized Bulk Rock Trace Elements (weight percent):					
Ni	29.552	66.825	45.500	37.711	35.300
Cr	87.859	145.233	143.400	150.245	136.100
Sc	20.199	20.889	25.500	25.671	19.000
V	184.075	184.734	205.100	204.274	183.600
Ba	683.665	605.286	711.700	610.333	736.600
Rb	78.000	60.431	61.152	73.418	68.502
Sr	181.886	178.794	209.300	265.068	395.500
Zr	148.707	131.565	119.543	123.888	194.580
Y	22.686	23.067	29.400	31.243	24.600
Nb	9.453	8.316	6.700	7.264	10.600
Ga	19.403	17.622	18.500	18.109	20.900
Cu	59.501	48.114	55.400	38.109	33.500
Zn	148.454	122.463	118.900	122.286	97.500
Pb	13.731	7.425	9.700	10.448	14.800
La	14.229	16.434	17.600	16.219	26.500
Ce	31.940	37.323	33.100	36.517	50.700
Th	5.373	5.049	4.000	4.975	8.200
Nd	15.920	19.404	15.900	17.114	25.700
U	1.692	1.980	0.700	3.781	3.400
sum tr.	1756.320	1700.954	1831.095	########	2085.582
in %	0.176	0.170	0.183	0.180	0.209
sum m+tr	97.346	97.069	97.646	98.419	96.837
M+Toxides	97.386	97.111	97.689	98.463	96.885
w/LOI	99.794	99.537	99.650	99.730	99.174
if Fe3+	100.514	100.231	100.437	100.563	99.872

TABLE 6 PRESSURE AND TEMPERATURE CALCULATIONS

Sample	Assemblage	°C	±2s	kbar	±2s	Corr	sigma fit	fit	Metamorphic Event
191-05a	Grt-Amp-Bt*	650	25	2.9	1.2	N/A	N/A	N/A	M1
191-08a	Rt-Ilm-Ms-St-Ky-Grt-Bt[x]	639	23	7.1	0.8	0.084	0.79	1.61	M3
191-10a	Chl-And-Grt-Bt[x]	556	103	4.2	1.7	0.774	0.47	1.96	M2
191-17b	St-And-Grt-Bt[x]	652	100	5.9	2.2	0.879	0.66	1.96	M3
191-22a	St-Grt-Sil-Bt[x]	646	33	6.1	1.5	0.932	0.41	1.61	M3
191-36	St-Grt-Bt[x]	590	48	7.4	1.1	0.695	0.91	1.73	M3
191-46c	Grt-Cd-Bt[x]	613	73	4.5	1.1	0.499	0.24	1.61	M1

[x] Pressure and temperature calculated using the AV-PT mode of thermocalc (Powell and Holland (1994))

*Temperature calculated using the garnet-biotite Fe-Mg exchange thermometer and pressure caculated using the AV-PT mode of thermocalc (Powell and Holland (1994))

Corr is the correlation coefficient between the pressure and temperature uncertainties

Sigma Fit is equivalent to the MSWD

Fit is the expected value of Sigma Fit given the number of reactions used to determine the PT

TABLE 7A SCANNING ELECTRON MICROSCOPE ENERGY DISPERSION MICROSCOPY POINT DATA

Sample	Analysis Date	Mineral	Spectrum	SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
191-05a		Garnet Core	Spectrum 3	36.30	0.00	21.23	0.00	0.00	31.17
		Garnet Core	Spectrum 53	37.07	0.00	21.54	0.00	0.00	31.46
		Garnet Rim	Spectrum 45	36.62	0.00	21.48	0.00	0.00	32.31
		Garnet Rim	Spectrum 46	36.63	0.00	21.45	0.00	0.00	32.55
		Garnet Rim	Spectrum 47	36.57	0.00	21.38	0.00	0.00	32.78
		Garnet Rim	Spectrum 48	36.88	0.00	21.60	0.00	0.00	32.73
		Garnet Rim	Spectrum 54	38.12	0.00	22.27	0.00	0.00	33.29
		Garnet Rim	Spectrum 55	37.82	0.00	22.08	0.00	0.00	32.90
		Garnet Rim	Spectrum 56	37.78	0.00	21.94	0.00	0.00	32.74
		Garnet Rim	Spectrum 57	37.80	0.00	22.05	0.00	0.00	32.57
		Garnet Rim*	Spectrum 58	37.82	0.00	22.05	0.00	0.00	31.70
		Biotite	Spectrum 5	37.95	1.78	18.83	0.00	0.00	17.80
		Biotite	Spectrum 6	38.42	1.66	19.06	0.00	0.00	17.66
		Biotite*	Spectrum 34	38.60	1.82	18.44	0.00	0.00	17.96
		Feldspar	Spectrum 16	56.44	0.00	27.66	0.00	0.00	0.19
		Feldspar	Spectrum 38	56.96	0.00	27.38	0.00	0.00	0.33
		Feldspar*	Spectrum 43	56.13	0.00	27.73	0.00	0.00	0.43
		S1 Feldspar	Spectrum 60	55.26	0.00	27.32	0.00	0.00	0.34
		S1 Feldspar	Spectrum 61	55.21	0.00	27.64	0.00	0.00	0.28
		S1 Feldspar	Spectrum 62	55.18	0.00	27.50	0.00	0.00	0.25
		S1 Feldspar	Spectrum 63	55.01	0.00	28.01	0.00	0.00	0.40
		S1 Feldspar	Spectrum 64	54.95	0.00	27.63	0.00	0.00	0.41
		S1 Feldspar	Spectrum 65	55.22	0.00	27.68	0.00	0.00	0.34
		S1 Feldspar	Spectrum 70	55.66	0.00	27.73	0.00	0.00	0.22
		S1 Feldspar	Spectrum 71	55.06	0.00	27.79	0.00	0.00	0.17
		S1 Feldspar	Spectrum 76	56.00	0.00	27.90	0.00	0.00	0.48
		S1 Feldspar	Spectrum 96	55.37	0.00	27.90	0.00	0.00	0.30
		S1 Feldspar	Spectrum 100	55.88	0.00	27.75	0.00	0.00	0.21
		S1 Feldspar	Spectrum 112	55.21	0.00	27.61	0.00	0.00	0.31
		Amphibole	Spectrum 110	52.77	0.00	1.69	0.00	0.00	25.79
		Amphibole	Spectrum 111	53.30	0.00	1.96	0.00	0.00	26.01
		Amphibole	Spectrum 114	53.44	0.14	2.11	0.14	0.14	25.72
		Amphibole	Spectrum 115	52.58	0.00	2.00	0.00	0.00	25.94
		Amphibole	Spectrum 117	52.32	0.00	1.85	0.00	0.00	25.68
		Amphibole	Spectrum 119	53.04	0.00	1.98	0.00	0.00	25.75
		Amphibole	Spectrum 121	53.11	0.00	1.58	0.00	0.00	25.76
		Amphibole*	Spectrum 123	52.81	0.12	1.96	0.00	0.00	25.94
		Amphibole	Spectrum 124	53.53	0.00	1.84	0.00	0.00	25.97
		Amphibole	Spectrum 127	52.09	0.00	2.05	0.00	0.00	25.98
		Amphibole	Spectrum 129	53.54	0.00	1.14	0.00	0.00	26.08
		Amphibole	Spectrum 131	52.57	0.00	1.32	0.00	0.00	26.32
		Amphibole	Spectrum 139	53.70	0.00	1.22	0.00	0.00	26.00

TABLE 7B SCANNING ELECTRON MICROSCOPE ENERGY DISPERSION MICROSCOPY POINT DATA

Sample	Analysis Date	Mineral	Spectrum	SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
191-08a	4/19/2019	Garnet Core	Spectrum 3	38.14	0.00	22.07	0.00	0.00	32.81
		Garnet Core	Spectrum 4	38.02	0.00	21.55	0.00	0.00	33.05
		Garnet Rim	Spectrum 20	40.30	0.00	23.54	0.00	0.00	30.85

TABLE 7A SCANNING ELECTRON MICROSCOPE ENERGY DISPERSION MICROSCOPY POINT DATA

MnO	MgO	CaO	Na2O	K2O	Total
3.08	4.20	1.93	0.00	0.00	97.92
3.32	4.34	2.00	0.00	0.00	99.73
1.74	4.32	2.18	0.00	0.00	98.64
1.74	4.25	2.21	0.00	0.00	98.83
1.80	4.05	2.21	0.00	0.00	98.79
1.97	3.81	2.28	0.00	0.00	99.27
1.93	4.29	2.23	0.00	0.00	102.12
1.98	4.48	2.20	0.00	0.00	101.47
1.98	4.57	2.21	0.00	0.00	101.21
2.12	4.55	2.23	0.00	0.00	101.32
2.15	4.51	2.05	0.00	0.00	100.29
0.00	12.74	0.16	0.35	7.97	97.58
0.00	13.09	0.22	0.27	7.92	98.30
0.00	12.05	0.00	0.28	7.50	96.64
0.00	0.00	8.84	5.85	0.00	98.99
0.00	0.00	8.83	5.75	0.00	99.26
0.00	0.00	8.96	5.78	0.06	99.09
0.00	0.00	9.03	6.09	0.00	98.04
0.00	0.00	9.28	6.05	0.00	98.47
0.00	0.00	9.25	6.02	0.00	98.21
0.00	0.00	9.44	5.93	0.00	98.79
0.00	0.00	9.34	6.01	0.00	98.34
0.00	0.00	9.28	6.05	0.00	98.57
0.00	0.00	9.05	6.23	0.07	98.97
0.00	0.00	9.41	6.04	0.00	98.46
0.00	0.00	9.16	6.17	0.00	99.71
0.00	0.00	9.37	6.06	0.00	99.01
0.00	0.00	9.09	6.23	0.00	99.17
0.00	0.00	9.20	6.05	0.00	98.38
0.00	15.97	0.46	0.00	0.00	97.05
0.00	15.90	0.45	0.00	0.00	98.03
0.14	15.99	0.47	0.00	0.00	98.27
0.00	15.62	0.46	0.00	0.00	97.01
0.00	15.50	0.59	0.15	0.00	96.50
0.00	15.90	0.49	0.18	0.00	97.75
0.00	16.09	0.47	0.00	0.00	97.43
0.12	15.79	0.48	0.17	0.00	97.67
0.00	16.14	0.50	0.00	0.00	98.38
0.44	15.53	0.48	0.24	0.00	96.81
0.42	16.26	0.42	0.00	0.00	97.86
0.46	15.62	0.45	0.14	0.00	96.87
0.43	16.20	0.43	0.00	0.00	97.97

TABLE 7B SCANNING ELECTRON MICROSCOPE ENERGY DISPERSION MICROSCOPY POINT DATA

MnO	MgO	CaO	Na2O	K2O	Total
2.85	3.69	2.69	0.00	0.00	102.25
2.76	3.39	2.44	0.00	0.00	101.20
0.00	4.30	3.22	0.00	0.00	102.20

Sample	Analysis Date	Mineral	Spectrum	SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
		Garnet Rim	Spectrum 21	39.03	0.00	19.60	0.00	0.00	34.00
		Garnet Rim	Spectrum 28	39.14	0.00	20.29	0.00	0.00	34.44
		Garnet Rim	Spectrum 38	36.54	0.00	21.55	0.00	0.00	31.38
		Garnet Rim	Spectrum 69	36.83	0.00	21.49	0.00	0.00	33.55
		Garnet Rim	Spectrum 71	37.04	0.00	21.60	0.00	0.00	32.90
		Garnet Rim	Spectrum 72	37.11	0.00	21.79	0.00	0.00	33.41
		Garnet Rim*	Spectrum 73	37.25	0.00	21.71	0.00	0.00	33.77
		Garnet Rim	Spectrum 74	37.25	0.00	21.74	0.00	0.00	34.16
		Garnet Rim	Spectrum 75	37.31	0.00	21.65	0.00	0.00	33.03
		Garnet Rim	Spectrum 76	37.58	0.00	21.36	0.00	0.00	33.28
		Garnet Rim	Spectrum 77	37.29	0.00	21.69	0.00	0.00	33.13
		Garnet Rim	Spectrum 78	37.77	0.00	21.81	0.00	0.00	33.38
		Garnet Rim	Spectrum 79	37.40	0.00	21.84	0.00	0.00	33.48
		Garnet Rim	Spectrum 80	37.84	0.00	21.84	0.00	0.00	33.70
		Garnet Rim	Spectrum 81	37.50	0.00	21.70	0.00	0.00	33.39
		Garnet Rim	Spectrum 82	37.61	0.00	22.01	0.00	0.00	33.59
		Garnet Rim	Spectrum 83	36.77	2.93	21.25	0.00	0.00	33.00
		Garnet Rim	Spectrum 84	37.57	0.00	21.34	0.00	0.00	33.45
		Garnet Rim	Spectrum 85	37.58	0.00	21.76	0.00	0.00	33.73
		Garnet Rim	Spectrum 87	37.78	0.00	21.48	0.00	0.00	33.31
		Garnet Rim	Spectrum 88	33.41	0.17	21.76	0.00	0.00	37.90
		Garnet Rim	Spectrum 89	37.53	0.00	21.72	0.00	0.00	33.73
		Biotite	Spectrum 92	36.07	2.43	19.70	0.00	0.00	17.48
		Biotite*	Spectrum 95	36.93	2.25	19.59	0.00	0.00	17.10
		Biotite	Spectrum 55	36.85	1.96	19.86	0.00	0.00	16.85
		Feldspar*	Spectrum 104	60.93	0.00	24.27	0.00	0.00	0.00
		Garnet Core	Spectrum 115	37.22	0.00	21.30	0.00	0.00	29.09
		Garnet Core	Spectrum 116	37.40	0.00	21.46	0.00	0.00	29.29
		Garnet Core	Spectrum 117	37.06	0.00	21.46	0.00	0.00	28.62
		Garnet Core	Spectrum 118	37.27	0.00	21.61	0.00	0.00	28.93
		Garnet Rim	Spectrum 145	37.19	0.00	21.54	0.00	0.00	33.42
		Garnet Rim	Spectrum 146	37.20	0.00	21.67	0.00	0.00	33.37
		Garnet Rim	Spectrum 147	37.85	0.00	21.88	0.00	0.00	33.35
		Garnet Rim	Spectrum 149	37.41	0.00	21.61	0.00	0.00	33.67
		Garnet Rim	Spectrum 150	37.53	0.00	21.56	0.00	0.00	33.40
		Garnet Rim	Spectrum 151	37.68	0.00	21.74	0.00	0.00	33.61
		Garnet Rim	Spectrum 152	36.89	0.00	21.77	0.00	0.00	33.94
		Garnet Rim	Spectrum 153	37.51	0.00	21.74	0.00	0.00	33.21
		Garnet Rim	Spectrum 154	37.30	0.00	21.55	0.00	0.00	33.86
		Biotite	Spectrum 157	35.98	1.85	0.00	0.00	0.00	35.98
				SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
		Staurolite	Spectrum 48	27.40	0.70	54.56	0.00	0.00	13.11
		Staurolite*	Spectrum 51	27.40	0.78	54.32	0.00	0.00	13.22

TABLE 7C SCANNING ELECTRON MICROSCOPE ENERGY DISPERSION MICROSCOPY POINT DATA

Sample	Analysis Date	Mineral	Spectrum	SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
191-10a	4/24/2019	Garnet Core	Spectrum 1	36.88	0.00	21.54	0.00	0.00	33.73
		Garnet Core	Spectrum 3	38.88	0.00	19.63	0.00	0.00	32.34
		Garnet Core	Spectrum 5	38.19	0.00	22.53	0.00	0.00	31.68
		Garnet Core	Spectrum 6	38.28	0.00	20.41	0.00	0.00	33.62

MnO	MgO	CaO	Na2O	K2O	Total
3.60	0.00	2.78	0.00	0.00	99.01
1.30	3.12	4.05	0.00	0.00	102.33
1.21	3.91	4.41	0.00	0.00	99.00
2.68	3.03	3.15	0.00	0.00	100.72
2.31	3.49	3.52	0.00	0.00	100.85
2.37	3.47	3.25	0.00	0.00	101.39
2.50	3.37	2.92	0.00	0.00	101.52
2.06	3.56	3.12	0.00	0.00	101.88
1.19	3.54	4.33	0.00	0.00	101.05
0.74	3.71	4.73	0.00	0.00	101.40
0.74	3.58	4.40	0.00	0.00	100.85
0.56	3.42	4.91	0.00	0.00	101.85
0.29	3.31	5.12	0.00	0.00	101.43
0.44	3.19	5.02	0.00	0.00	102.03
0.29	3.25	5.22	0.00	0.00	101.35
0.30	3.15	5.22	0.00	0.00	101.88
0.27	3.02	5.24	0.00	0.00	102.48
0.36	2.95	5.47	0.00	0.00	101.15
0.32	2.93	5.63	0.00	0.00	101.96
0.40	2.80	6.00	0.00	0.00	101.78
21.76	2.70	5.80	0.00	0.00	102.24
0.46	2.88	5.70	0.00	0.00	102.02
0.00	10.21	0.00	0.27	9.10	95.27
0.00	10.70	0.00	0.00	8.95	95.52
0.00	11.17	0.17	0.32	8.60	95.78
0.00	0.00	5.63	8.29	0.12	99.25
5.48	1.94	6.43	0.00	0.00	101.47
5.37	2.05	6.25	0.00	0.00	101.84
5.99	1.86	6.28	0.00	0.00	101.27
5.69	1.93	6.43	0.00	0.00	101.86
2.71	2.70	4.05	0.00	0.00	101.61
1.51	3.30	4.42	0.00	0.00	101.46
0.65	3.07	5.39	0.00	0.00	102.18
0.56	2.82	5.52	0.00	0.00	101.60
0.57	2.83	5.59	0.00	0.00	101.47
0.61	2.74	5.48	0.00	0.00	101.86
0.64	2.98	5.25	0.00	0.00	101.46
0.60	2.73	5.77	0.00	0.00	101.56
0.73	2.87	5.15	0.00	0.00	101.47
0.00	11.32	0.17	0.31	9.16	95.52

MnO	MgO	CaO	Na2O	K2O	ZnO	Total
0.17	2.08	0.00	0.00	0.00	0.36	98.39
0.00	1.73	0.00	0.00	0.00	0.51	97.95

TABLE 7C SCANNING ELECTRON MICROSCOPE ENERGY DISPERSION MICROSCOPY POINT DATA

MnO	MgO	CaO	Na2O	K2O	Total
2.46	4.18	1.83	0.00	0.00	100.62
1.92	4.59	1.64	0.00	0.00	99.01
2.96	3.62	1.99	0.00	0.00	100.97
2.90	5.11	1.33	0.00	0.00	101.65

Sample	Analysis Date	Mineral	Spectrum	SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
		Garnet Core	Spectrum 7	37.44	0.00	19.66	0.00	0.00	33.33
		Garnet Core	Spectrum 8	38.60	0.00	24.22	0.00	0.00	32.79
		Garnet Core	Spectrum 13	37.27	0.00	21.60	0.00	0.00	33.59
		Garnet Core	Spectrum 14	37.06	0.00	21.36	0.00	0.00	33.54
		Garnet Core	Spectrum 15	37.27	0.00	21.59	0.00	0.00	33.46
		Garnet Core	Spectrum 16	36.99	0.00	21.42	0.00	0.00	33.69
		Garnet Core	Spectrum 17	37.50	0.00	21.66	0.00	0.00	33.77
		Garnet Core	Spectrum 18	37.52	0.00	21.82	0.00	0.00	33.68
		Garnet Core	Spectrum 19	37.53	0.00	21.46	0.00	0.00	33.43
		Garnet Core	Spectrum 20	37.92	0.00	21.93	0.00	0.00	33.63
		Garnet Core	Spectrum 21	36.99	0.00	21.49	0.00	0.00	33.55
		Garnet Core	Spectrum 22	37.05	0.00	21.43	0.00	0.00	33.53
		Garnet Core	Spectrum 23	36.79	0.00	21.45	0.00	0.00	33.46
		Garnet RIM*	Spectrum 38	36.10	0.00	21.03	0.00	0.00	33.73
		Garnet RIM	Spectrum 39	36.73	0.00	21.43	0.00	0.00	33.90
		Garnet RIM	Spectrum 40	36.28	0.00	21.27	0.00	0.00	33.85
		Garnet RIM	Spectrum 41	37.05	0.00	21.56	0.00	0.00	34.26
		Garnet RIM	Spectrum 42	36.93	0.00	21.42	0.00	0.00	33.98
		Garnet RIM	Spectrum 43	36.82	0.00	21.48	0.00	0.00	34.20
		Garnet RIM	Spectrum 44	36.83	0.00	21.47	0.00	0.00	33.80
		Garnet RIM	Spectrum 45	36.21	0.00	20.98	0.00	0.00	33.70
		Biotite	Spectrum 24	37.11	1.66	20.69	0.00	0.00	17.41
		Biotite	Spectrum 25	35.91	1.62	19.87	0.00	0.00	17.47
		Biotite*	Spectrum 26	36.27	1.65	20.19	0.00	0.00	17.38
		Feldspar*	Spectrum 28	57.53	0.00	26.87	0.00	0.00	0.24
		Feldspar	Spectrum 30	57.47	0.00	26.85	0.00	0.00	0.17
		Garnet Core	Spectrum 73	36.77	0.00	21.34	0.00	0.00	34.00
		Garnet Core	Spectrum 74	36.81	0.00	21.51	0.00	0.00	34.07
		Garnet Core	Spectrum 76	37.54	0.00	21.62	0.00	0.00	33.82
		Garnet Core	Spectrum 77	36.90	0.00	21.46	0.00	0.00	33.73
		Garnet Core	Spectrum 78	37.23	0.00	21.33	0.00	0.00	33.93
		Garnet Core	Spectrum 79	36.59	0.00	21.35	0.00	0.00	33.77
		Garnet Core	Spectrum 80	37.25	0.00	21.62	0.00	0.00	34.06
		Garnet Core	Spectrum 81	36.86	0.00	21.30	0.00	0.00	33.87
		Garnet Core	Spectrum 82	37.12	0.00	21.49	0.00	0.00	33.79
		Garnet Core	Spectrum 83	37.21	0.00	21.57	0.00	0.00	33.90
		Garnet Rim	Spectrum 93	36.31	0.00	21.17	0.00	0.00	33.50
		Garnet Rim	Spectrum 95	36.26	0.00	21.19	0.00	0.00	34.10
		Garnet Rim	Spectrum 97	36.73	0.00	21.44	0.00	0.00	33.89
		Garnet Rim	Spectrum 99	37.09	0.00	21.39	0.00	0.00	34.20
		Garnet Rim	Spectrum 101	36.96	0.00	21.52	0.00	0.00	34.03
		Garnet Rim	Spectrum 103	37.13	0.00	21.45	0.00	0.00	34.20
		Biotite	Spectrum 84	38.32	1.75	20.59	0.00	0.00	16.40
		Biotite	Spectrum 88	37.56	1.86	20.75	0.00	0.00	16.16
		Feldspar	Spectrum 90	58.16	0.00	27.39	0.00	0.00	0.35

TABLE 7D SCANNING ELECTRON MICROSCOPE ENERGY DISPERSION MICROSCOPY POINT DATA

Sample	Analysis Date	Mineral	Spectrum	SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
191-17b	4/5/2019	Garnet Core	Spectrum 1	36.82	0.00	21.32	0.00	0.00	29.33
		Garnet Core	Spectrum 5	36.56	0.00	21.36	0.00	0.00	29.73

MnO	MgO	CaO	Na2O	K2O	Total
2.48	5.14	2.10	0.00	0.00	100.15
0.00	3.21	1.69	0.00	0.00	100.51
2.48	4.23	1.72	0.00	0.00	100.88
2.50	4.22	1.80	0.00	0.00	100.49
2.45	4.23	1.84	0.00	0.00	100.85
2.53	4.28	1.78	0.00	0.00	100.67
2.55	4.28	1.73	0.00	0.00	101.47
2.51	4.25	1.73	0.00	0.00	101.51
2.51	4.29	1.74	0.00	0.00	100.97
2.54	4.17	1.69	0.00	0.00	101.88
2.45	4.22	1.73	0.00	0.00	100.44
2.42	4.28	1.76	0.00	0.00	100.46
2.50	4.23	1.78	0.00	0.00	100.21
3.76	3.03	1.73	0.00	0.00	99.38
2.95	3.61	1.74	0.00	0.00	100.36
3.26	3.50	1.67	0.00	0.00	99.83
2.48	3.94	1.69	0.00	0.00	100.97
2.91	3.68	1.76	0.00	0.00	100.70
2.75	3.80	1.69	0.00	0.00	100.75
3.02	3.51	1.72	0.00	0.00	100.34
3.31	3.28	1.66	0.00	0.00	99.15
0.00	11.43	0.00	0.26	8.51	97.07
0.00	11.22	0.12	0.27	8.49	94.98
0.11	11.22	0.00	0.29	8.55	95.66
0.00	0.00	8.17	6.79	0.06	99.66
0.00	0.00	8.22	6.89	0.00	99.61
2.26	4.08	1.72	0.00	0.00	100.17
2.24	4.14	1.72	0.00	0.00	100.48
2.29	4.18	1.76	0.00	0.00	101.20
2.27	4.16	1.77	0.00	0.00	100.29
2.20	4.10	1.75	0.00	0.00	100.54
2.19	4.16	1.75	0.00	0.00	99.81
2.32	4.16	1.77	0.00	0.00	101.17
2.29	4.16	1.75	0.00	0.00	100.22
2.26	4.13	1.74	0.00	0.00	100.54
2.24	4.15	1.72	0.00	0.00	100.80
3.61	3.32	1.76	0.00	0.00	99.67
3.01	3.50	1.72	0.00	0.00	99.78
2.70	3.83	1.71	0.00	0.00	100.31
2.41	3.97	1.74	0.00	0.00	100.80
2.31	4.00	1.69	0.00	0.00	100.52
2.26	4.04	1.72	0.00	0.00	100.80
0.00	11.00	0.00	0.32	8.60	96.97
0.00	11.17	0.15	0.34	8.50	96.48
0.00	0.00	8.29	6.68	0.00	100.87

TABLE 7D SCANNING ELECTRON MICROSCOPE ENERGY DISPERSION MICROSCOPY POINT DATA

MnO	MgO	CaO	Na2O	K2O	Total
7.04	3.63	1.36	0.00	0.00	99.50
6.98	3.68	1.43	0.00	0.00	99.73

Sample	Analysis Date	Mineral	Spectrum	SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
		Garnet Core	Spectrum 6	36.43	0.00	21.30	0.00	0.00	29.55
		Garnet Core	Spectrum 7	36.40	0.00	21.15	0.00	0.00	29.48
		Garnet Core	Spectrum 8	36.41	0.00	21.15	0.00	0.00	29.66
		Garnet Core	Spectrum 9	36.39	0.00	21.13	0.00	0.00	29.53
		Garnet Core	Spectrum 10	36.61	0.00	21.27	0.00	0.00	29.49
		Garnet Rim	Spectrum 2	37.01	0.00	21.61	0.00	0.00	33.10
		Garnet Rim	Spectrum 136	36.56	0.00	21.28	0.00	0.00	33.31
		Garnet Rim	Spectrum 137	36.93	0.00	21.54	0.00	0.00	33.11
		Garnet Rim	Spectrum 138	36.67	0.00	21.52	0.00	0.00	33.16
		Garnet Rim	Spectrum 139	36.49	0.00	21.42	0.00	0.00	33.26
		Garnet Rim	Spectrum 140	37.02	0.00	21.50	0.00	0.00	32.88
		Garnet Rim	Spectrum 141	37.31	0.00	21.57	0.00	0.00	32.80
		Garnet Rim	Spectrum 142	37.06	0.00	21.52	0.00	0.00	32.78
		Garnet Rim	Spectrum 143	37.05	0.00	21.43	0.00	0.00	32.38
		Garnet Rim*	Spectrum 144	36.64	0.00	21.36	0.00	0.00	32.53
		Garnet Rim	Spectrum 145	35.26	0.00	20.03	0.00	0.00	30.34
		Garnet Rim	Spectrum 146	30.63	0.00	16.92	0.00	0.00	31.73
		Garnet Rim	Spectrum 147	32.25	0.00	18.03	0.00	0.00	32.04
		Garnet Rim	Spectrum 148	33.13	0.00	18.69	0.00	0.00	31.71
		Garnet Rim	Spectrum 149	34.81	0.00	20.03	0.00	0.00	31.57
		Garnet Rim	Spectrum 150	36.50	0.00	20.91	0.00	0.00	31.51
		Garnet Rim	Spectrum 151	36.64	0.00	21.08	0.00	0.00	31.71
		Biotite	Spectrum 3	35.53	1.77	19.67	0.00	0.00	18.67
		Biotite	Spectrum 20	35.84	1.80	20.12	0.00	0.00	17.91
		Feldspar*	Spectrum 33	59.82	0.00	25.20	0.00	0.00	0.20
		Feldspar	Spectrum 36	59.90	0.00	25.04	0.00	0.00	0.00
		Feldspar	Spectrum 50	60.30	0.00	25.50	0.00	0.00	0.18
		Biotite-Coarse Matrix	Spectrum 56	36.71	1.74	20.42	0.00	0.00	17.30
		Biotite-Coarse Matrix	Spectrum 58	35.97	1.71	20.22	0.00	0.00	17.73
		Biotite-Coarse Matrix	Spectrum 61	35.99	1.76	20.49	0.00	0.00	17.79
		Biotite-Coarse Matrix*	Spectrum 63	36.05	1.81	19.95	0.00	0.00	17.73
		Biotite-Coarse Matrix	Spectrum 73	35.90	1.71	20.02	0.00	0.00	17.65
		Biotite-Coarse Matrix	Spectrum 76	35.80	1.73	20.20	0.00	0.00	17.54
		Biotite-Coarse Matrix	Spectrum 85	36.63	1.77	19.84	0.00	0.00	18.46
		Biotite-Coarse Matrix	Spectrum 86	36.30	1.81	20.51	0.00	0.00	17.83
		Muscovite after Andalusite	Spectrum 127	45.86	0.37	37.41	0.00	0.00	0.61
		Muscovite after Andalusite	Spectrum 128	46.05	0.37	37.51	0.00	0.00	0.61
		Muscovite after Andalusite	Spectrum 130	46.61	0.60	37.22	0.00	0.00	0.66
				SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
		Matrix Staurolite	Spectrum 93*	26.70	0.77	54.73	0.00	0.00	13.09
		Matrix Staurolite	Spectrum 95	26.49	0.61	54.75	0.00	0.00	13.12
		Matrix Staurolite	Spectrum 97	26.83	0.57	54.38	0.00	0.00	12.99
		Matrix Staurolite	Spectrum 100	26.74	0.61	54.67	0.00	0.00	13.27
				SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
		Matrix Staurolite	Spectrum 104	26.08	0.57	54.90	0.00	0.00	13.21
		Matrix Staurolite	Spectrum 106	26.28	0.65	54.65	0.00	0.00	13.30

MnO	MgO	CaO	Na2O	K2O	Total
6.99	3.58	1.48	0.00	0.00	99.33
7.02	3.60	1.46	0.00	0.00	99.12
7.09	3.72	1.39	0.00	0.00	99.42
6.96	3.59	1.37	0.00	0.00	98.96
7.06	3.66	1.43	0.00	0.00	99.52
3.81	3.60	1.39	0.00	0.00	100.52
3.77	3.09	1.56	0.00	0.00	99.57
3.87	3.56	1.48	0.00	0.00	100.51
3.83	3.44	1.39	0.00	0.00	100.02
3.92	3.62	1.39	0.00	0.00	100.09
3.75	3.73	1.36	0.00	0.00	100.24
3.82	3.90	1.44	0.00	0.00	100.83
3.85	3.92	1.35	0.00	0.00	100.49
3.87	4.09	1.37	0.00	0.00	100.18
3.87	3.87	1.45	0.00	0.00	99.72
3.71	3.61	1.22	0.88	0.00	95.05
4.06	2.98	1.22	0.18	0.00	87.72
4.23	3.31	1.23	0.00	0.00	91.09
4.37	3.41	1.20	0.00	0.00	92.51
4.62	3.62	1.17	0.00	0.00	95.82
4.96	3.74	1.19	0.00	0.00	98.81
4.97	3.98	1.21	0.00	0.00	99.58
0.00	10.20	0.13	0.49	8.54	94.99
0.00	10.75	0.00	0.56	8.74	95.72
0.00	0.00	6.36	7.89	0.07	99.56
0.00	0.00	6.28	7.90	0.00	99.12
0.00	0.00	6.55	7.86	0.08	100.46
0.00	10.84	0.00	0.44	8.67	96.12
0.00	10.48	0.00	0.49	8.72	95.32
0.00	11.17	0.00	0.43	8.61	96.25
0.00	10.27	0.00	0.46	8.81	95.08
0.00	10.60	0.00	0.47	8.58	94.93
0.00	10.56	0.00	0.51	8.72	95.07
0.00	10.59	0.00	0.45	8.71	96.45
0.00	10.94	0.00	0.54	8.88	96.81
0.00	0.42	0.00	2.04	7.80	94.51
0.00	0.39	0.11	2.03	7.72	94.78
0.00	0.48	0.10	1.82	8.06	95.55

MnO	MgO	CaO	Na2O	K2O	ZnO	Total
0.00	1.92	0.00	0.00	0.00	0.82	98.04
0.20	1.83	0.00	0.00	0.00	0.97	97.96
0.26	1.92	0.00	0.00	0.00	0.92	97.88
0.23	1.82	0.00	0.16	0.00	0.83	98.32

MnO	MgO	CaO	Na2O	K2O	ZnO	Total
0.21	1.83	0.00	0.00	0.00	0.87	97.66
0.21	1.85	0.00	0.00	0.00	0.85	97.79

TABLE 7E SCANNING ELECTRON MICROSCOPE ENERGY DISPERSION MICROSCOPY POINT DATA

Sample	Analysis Date	Mineral	Spectrum	SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
191-22a	4/2/2019	Garnet Core	Spectrum 1	36.98	0.00	21.49	0.00	0.00	32.92
		Garnet Core	Spectrum 2	36.60	0.00	21.24	0.00	0.00	32.61
		Garnet Core	Spectrum 8	37.01	0.00	21.64	0.00	0.00	33.13
		Garnet Core	Spectrum 9	36.59	0.00	21.36	0.00	0.00	32.89
		Garnet Core	Spectrum 10	36.87	0.00	21.46	0.00	0.00	32.73
		Feldspar	Spectrum 13	59.69	0.00	25.80	0.00	0.00	0.28
		Feldspar	Spectrum 18	36.10	2.10	20.10	0.00	0.00	17.88
		Feldspar	Spectrum 19	36.03	2.12	20.26	0.00	0.00	18.03
		Feldspar*	Spectrum 56	59.03	0.00	25.69	0.00	0.00	0.19
		Garnet Rim	Spectrum 22	36.23	0.00	21.02	0.00	0.00	35.10
		Garnet Rim	Spectrum 23	36.53	0.00	21.20	0.00	0.00	35.02
		Garnet Rim	Spectrum 24	36.06	0.00	20.87	0.00	0.00	34.66
		Garnet Rim	Spectrum 25	36.78	0.00	21.36	0.00	0.00	34.82
		Garnet Rim	Spectrum 26	42.17	0.00	24.68	0.00	0.00	34.71
		Garnet Rim	Spectrum 27	36.42	0.00	21.07	0.00	0.00	34.34
		Garnet Rim	Spectrum 28	36.75	0.00	21.37	0.00	0.00	34.20
		Garnet Rim	Spectrum 29	36.75	0.00	21.34	0.00	0.00	34.17
		Garnet Rim	Spectrum 30	36.91	0.00	21.20	0.00	0.00	33.78
		Garnet Rim	Spectrum 31	36.90	0.00	21.34	0.00	0.00	33.93
		Garnet Rim	Spectrum 32	37.02	0.00	21.35	0.00	0.00	34.11
		Garnet Rim	Spectrum 33	36.48	0.00	21.48	0.00	0.00	33.86
		Garnet Rim	Spectrum 34	37.15	0.00	21.56	0.00	0.00	33.96
		Garnet Rim	Spectrum 35	37.37	0.00	21.57	0.00	0.00	34.10
		Garnet Rim	Spectrum 68	38.13	0.00	21.90	0.00	0.00	35.16
		Garnet Rim	Spectrum 69	37.27	0.00	21.75	0.00	0.00	35.04
		Garnet Rim	Spectrum 70	37.80	0.00	21.69	0.00	0.00	35.12
		Garnet Rim	Spectrum 71	37.50	0.00	21.62	0.00	0.00	34.60
		Garnet Rim	Spectrum 72	37.07	0.00	21.77	0.00	0.00	34.68
		Garnet Rim	Spectrum 73	37.01	0.00	21.70	0.00	0.00	34.26
		Garnet Rim	Spectrum 74	36.97	0.00	21.41	0.00	0.00	34.27
		Garnet Rim	Spectrum 75	37.21	0.00	21.71	0.00	0.00	34.10
		Garnet Rim	Spectrum 76	36.86	0.00	21.64	0.00	0.00	33.94
		Garnet Rim	Spectrum 77	36.97	0.00	21.47	0.00	0.00	33.76
		Garnet Rim*	Spectrum 78	37.34	0.00	21.36	0.00	0.00	33.67
		Biotite	Spectrum 60	36.47	1.03	21.96	0.00	0.00	17.12
		Biotite*	Spectrum 66	36.49	1.40	21.41	0.00	0.00	17.47
		Muscovite	Spectrum 49	45.11	0.65	36.60	0.00	0.00	0.92
		Muscovite	Spectrum 51	45.60	0.58	37.01	0.00	0.00	0.69
		Muscovite	Spectrum 52	45.24	0.58	36.71	0.00	0.00	0.94
		Muscovite*	Spectrum 54	45.32	0.59	37.00	0.00	0.00	0.86
		Garnet Core	Spectrum 110	36.86	0.00	21.62	0.00	0.00	30.94
		Garnet Core	Spectrum 111	36.84	0.00	21.44	0.00	0.00	30.90
		Garnet Core	Spectrum 112	36.82	0.00	21.56	0.00	0.00	30.91
		Garnet Rim	Spectrum 120	36.29	0.00	21.25	0.00	0.00	34.91
		Garnet Rim	Spectrum 121	38.08	0.00	22.25	0.00	0.00	34.81
		Garnet Rim	Spectrum 122	36.75	0.00	21.56	0.00	0.00	34.62
		Garnet Rim	Spectrum 124	37.22	0.00	21.57	0.00	0.00	34.69
		Garnet Rim	Spectrum 125	37.27	0.00	21.71	0.00	0.00	34.29
		Garnet Rim	Spectrum 126	36.99	0.00	21.58	0.00	0.00	34.38

TABLE 7E SCANNING ELECTRON MICROSCOPE ENERGY DISPERSION MICROSCOPY POINT DATA

MnO	MgO	CaO	Na2O	K2O	Total
3.29	4.05	1.61	0.00	0.00	100.34
3.36	4.05	1.64	0.00	0.00	99.49
3.35	4.10	1.59	0.00	0.00	100.83
3.17	4.16	1.59	0.00	0.00	99.77
3.32	4.20	1.57	0.00	0.00	100.14
0.00	0.00	6.75	7.73	0.00	100.25
0.00	10.18	0.00	0.28	9.14	95.77
0.00	10.30	0.00	0.24	9.13	96.11
0.00	0.00	7.01	7.53	0.00	99.45
1.65	3.51	1.65	0.00	0.00	99.15
1.54	3.65	1.66	0.00	0.00	99.60
1.58	3.63	1.68	0.00	0.00	98.49
1.62	4.01	1.69	0.00	0.00	100.29
1.69	4.82	1.75	0.00	0.00	109.82
1.80	4.15	1.62	0.00	0.00	99.41
1.68	4.23	1.60	0.00	0.00	99.83
1.80	4.42	1.59	0.00	0.00	100.06
1.81	4.31	1.66	0.00	0.00	99.66
1.94	4.24	1.64	0.00	0.00	99.98
1.82	4.27	1.66	0.00	0.00	100.23
1.79	4.14	1.66	0.00	0.00	99.41
1.94	4.41	1.64	0.00	0.00	100.67
2.05	4.46	1.63	0.00	0.00	101.19
1.73	3.60	1.72	0.00	0.00	102.23
1.84	3.86	1.73	0.00	0.00	101.49
1.75	3.83	1.71	0.00	0.00	101.90
1.81	3.92	1.67	0.00	0.00	101.11
1.86	4.02	1.66	0.00	0.00	101.05
1.85	4.02	1.63	0.00	0.00	100.48
1.85	4.10	1.59	0.00	0.00	100.20
2.03	4.15	1.65	0.00	0.00	100.85
1.98	4.16	1.65	0.00	0.00	100.22
2.01	4.19	1.67	0.00	0.00	100.08
2.02	4.38	1.67	0.00	0.00	100.42
0.00	10.59	0.32	0.40	7.32	95.21
0.00	11.12	0.27	0.64	7.83	96.63
0.00	0.53	0.00	1.27	9.22	94.31
0.00	0.36	0.00	1.41	9.10	94.75
0.00	0.51	0.00	1.33	8.97	94.29
0.00	0.40	0.00	1.46	9.27	94.91
0.00	3.32	2.67	0.00	0.00	100.47
0.00	3.39	2.74	0.00	0.00	100.34
0.00	3.48	2.75	0.00	0.00	100.54
1.03	4.15	1.69	0.00	0.00	99.32
0.00	4.46	1.64	0.00	0.00	102.29
0.00	4.45	1.67	0.00	0.00	100.14
0.00	4.61	1.72	0.00	0.00	100.93
0.00	4.54	1.70	0.00	0.00	100.70
0.00	4.42	1.77	0.00	0.00	100.33

Sample	Analysis Date	Mineral	Spectrum	SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
		Garnet Rim	Spectrum 127	37.13	0.00	21.62	0.00	0.00	34.41
		Garnet Rim	Spectrum 128	36.96	0.00	21.69	0.00	0.00	34.45
		Garnet Rim	Spectrum 129	37.58	0.00	21.79	0.00	0.00	34.53
		Garnet Rim	Spectrum 130	37.18	0.00	21.78	0.00	0.00	34.43
		Garnet Rim	Spectrum 131	36.69	0.00	21.44	0.00	0.00	34.44
		Garnet Rim	Spectrum 132	36.99	0.00	21.86	0.00	0.00	34.52
		Garnet Rim	Spectrum 134	36.96	0.00	21.67	0.00	0.00	34.63
		Garnet Rim	Spectrum 135	37.90	0.00	22.03	0.00	0.00	34.32
		Garnet Rim	Spectrum 136	37.28	0.00	21.97	0.00	0.00	34.36
		Garnet Rim	Spectrum 137	37.45	0.00	21.85	0.00	0.00	34.41
		Garnet Rim	Spectrum 138	37.70	0.00	21.95	0.00	0.00	34.32
		Garnet Rim	Spectrum 139	37.79	0.00	21.90	0.00	0.00	34.35
		Garnet Rim	Spectrum 140	37.96	0.00	22.06	0.00	0.00	34.59
		Muscovite	Spectrum 152	46.29	0.85	36.23	0.00	0.00	1.15
		Biotite	Spectrum 174	37.22	2.31	20.79	0.00	0.00	17.09
		Feldspar	Spectrum 185	59.61	0.00	28.65	0.00	0.00	0.12
		Biotite	Spectrum 95	37.29	2.34	21.06	0.00	0.00	15.46
				SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
		Staurolite in Biotite*	Spectrum 84	27.40	0.72	54.53	0.00	0.00	11.41
		Staurolite in Biotite	Spectrum 88	27.52	0.78	54.28	0.00	0.00	11.69
		Staurolite	Spectrum 103	26.84	0.66	54.82	0.00	0.00	12.14

TABLE 7F SCANNING ELECTRON MICROSCOPE ENERGY DISPERSION MICROSCOPY POINT DATA

Sample	Analysis Date	Mineral	Spectrum	SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
191-36									
		Muscovite*	Spectrum 11	46.45	0.58	37.01	0.00	0.00	0.88
		Muscovite	Spectrum 26	47.24	0.44	36.22	0.00	0.00	0.94
		Muscovite	Spectrum 62	46.52	0.50	35.53	0.00	0.00	1.29
		Biotite	Spectrum 27	37.57	1.54	20.92	0.00	0.00	15.90
		Biotite	Spectrum 39	37.68	1.43	20.53	0.00	0.00	16.90
		Biotite	Spectrum 47	37.04	1.63	20.05	0.00	0.00	17.02
		Biotite*	Spectrum 50	37.02	1.50	20.05	0.00	0.00	16.90
		Biotite	Spectrum 51	37.46	1.59	20.54	0.00	0.00	16.87
		Biotite	Spectrum 91	36.95	1.53	19.85	0.00	0.00	17.32
		Biotite	Spectrum 141	36.37	1.56	19.53	0.00	0.00	17.19
		Feldspar*	Spectrum 64	60.44	0.00	24.62	0.00	0.00	0.21
		Feldspar	Spectrum 67	60.39	0.00	25.29	0.00	0.00	0.23
		Feldspar	Spectrum 68	62.35	0.00	24.81	0.00	0.00	0.23
		Garnet Rim	Spectrum 103	37.01	0.00	21.67	0.00	0.00	33.73
		Garnet Rim*	Spectrum 104	36.88	0.00	21.45	0.00	0.00	33.62
		Garnet Rim	Spectrum 105	36.78	0.00	21.18	0.00	0.00	32.85
		Garnet Rim	Spectrum 106	36.83	0.00	21.35	0.00	0.00	32.92
		Garnet Rim	Spectrum 108	37.64	0.00	20.89	0.00	0.00	32.99
		Garnet Rim	Spectrum 112	36.03	0.00	20.72	0.00	0.00	32.59
		Garnet Rim	Spectrum 113	36.92	0.00	20.80	0.00	0.00	31.41
		Garnet Core	Spectrum 124	36.42	0.00	21.04	0.00	0.00	27.85
		Garnet Core	Spectrum 125	36.33	0.00	21.10	0.00	0.00	27.87
		Garnet Core	Spectrum 126	36.23	0.00	21.04	0.00	0.00	27.90
		Garnet Core	Spectrum 127	36.09	0.00	20.99	0.00	0.00	28.03
		Garnet Core	Spectrum 128	36.49	0.00	21.10	0.00	0.00	27.87

MnO	MgO	CaO	Na2O	K2O	Total	
0.00	4.54	1.68	0.00	0.00	100.62	
0.00	4.31	1.72	0.00	0.00	100.41	
0.00	4.54	1.74	0.00	0.00	101.52	
0.00	4.54	1.67	0.00	0.00	100.95	
0.00	4.47	1.69	0.00	0.00	100.06	
0.00	4.42	1.71	0.00	0.00	100.85	
0.00	4.37	1.67	0.00	0.00	100.77	
0.00	4.63	1.72	0.00	0.00	102.12	
0.00	4.53	1.72	0.00	0.00	101.46	
0.00	4.46	1.75	0.00	0.00	101.51	
0.00	4.54	1.73	0.00	0.00	101.78	
0.00	4.48	1.71	0.00	0.00	101.80	
0.00	4.50	1.67	0.00	0.00	102.39	
0.00	0.62	0.15	1.13	8.67	95.09	
0.00	10.41	0.11	0.37	8.77	97.08	
0.00	0.00	5.94	6.66	0.00	100.97	
0.00	11.39	0.00	0.35	8.79	96.70	
MnO	MgO	CaO	Na2O	K2O	ZnO	98.27
0.00	1.44	0.00	0.48	0.00	2.30	98.35
0.00	1.43	0.00	0.47	0.00	2.18	97.79
0.00	1.59	0.00	0.27	0.00	1.47	

TABLE 7F SCANNING ELECTRON MICROSCOPE ENERGY DISPERSION MICROSCOPY POINT DATA

MnO	MgO	CaO	Na2O	K2O	Total
0.00	0.53	0.15	1.29	8.19	95.09
0.00	0.72	0.17	1.31	8.35	95.39
0.00	0.97	0.09	0.98	8.58	94.45
0.00	12.08	0.10	0.21	8.68	96.99
0.00	11.85	0.13	0.22	8.40	97.14
0.00	11.22	0.15	0.19	8.53	95.82
0.00	11.49	0.12	0.21	8.37	95.66
0.00	11.52	0.12	0.26	8.32	96.67
0.00	11.55	0.18	0.21	8.58	96.16
0.00	11.63	0.10	0.17	8.63	95.18
0.00	0.00	5.63	8.17	0.00	99.09
0.00	0.00	6.14	7.82	0.00	99.87
0.00	0.00	5.83	7.71	0.06	100.98
0.00	2.75	2.82	0.00	0.00	99.67
1.69	2.80	3.06	0.16	0.00	99.66
0.00	2.74	3.27	0.12	0.00	98.83
0.00	2.75	3.46	0.00	0.00	99.35
0.00	2.76	3.51	0.00	0.00	100.26
0.00	2.92	3.25	0.00	0.00	99.19
0.00	2.53	3.37	0.00	0.00	99.35
0.00	1.62	3.07	0.10	0.00	98.91
0.00	1.67	3.01	0.09	0.00	98.93
0.00	1.61	3.00	0.09	0.00	98.65
0.00	1.61	3.12	0.00	0.00	98.53
0.00	1.53	3.11	0.00	0.00	98.98

Sample	Analysis Date	Mineral	Spectrum	SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
		Garnet Core	Spectrum 129	36.28	0.00	21.06	0.00	0.00	28.20
		Garnet Core	Spectrum 130	36.79	0.00	21.24	0.00	0.00	28.14
		Garnet Core	Spectrum 131	36.71	0.00	21.29	0.00	0.00	28.03
		Garnet Core	Spectrum 132	36.69	0.12	21.30	0.00	0.00	28.46
		Garnet Core	Spectrum 134	36.64	0.00	21.22	0.00	0.00	28.20
		Garnet Core	Spectrum 135	36.63	0.00	21.24	0.00	0.00	28.36
		Garnet Core	Spectrum 136	36.71	0.00	21.14	0.00	0.00	27.87
		Garnet Core	Spectrum 137	36.53	0.00	21.17	0.00	0.00	27.93
				SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
		Staurolite	Spectrum 198	27.52	0.54	54.46	0.00	0.00	13.54
		Staurolite*	Spectrum 199	27.44	0.49	54.71	0.00	0.00	13.66
		Staurolite	Spectrum 200	27.10	0.54	54.48	0.00	0.00	13.68
		Staurolite	Spectrum 201	27.31	0.54	54.48	0.00	0.00	13.69
		Staurolite	Spectrum 202	27.48	0.52	54.28	0.00	0.00	13.58

TABLE 7G SCANNING ELECTRON MICROSCOPE ENERGY DISPERSION MICROSCOPY POINT DATA

Sample	Analysis Date	Mineral	Spectrum	SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
191-46c	5/29/2019	Garnet Core	Spectrum 1	37.82	0.00	21.73	0.00	0.00	31.56
		Garnet Core	Spectrum 2	37.58	0.00	21.89	0.00	0.00	31.67
		Garnet Core	Spectrum 3	37.80	0.00	21.90	0.00	0.00	31.71
		Garnet Core	Spectrum 4	37.60	0.00	21.69	0.00	0.00	31.63
		Garnet Core	Spectrum 5	37.77	0.00	21.76	0.00	0.00	31.63
		Garnet Core	Spectrum 6	37.52	0.00	21.71	0.00	0.00	31.78
		Feldspar	Spectrum 9	58.35	0.00	26.41	0.00	0.00	0.00
		Feldspar	Spectrum 10	58.39	0.00	26.53	0.00	0.00	0.00
		Feldspar*	Spectrum 11	58.63	0.00	26.64	0.00	0.00	0.00
		Feldspar	Spectrum 13	58.43	0.00	26.47	0.00	0.00	0.00
		Biotite	Spectrum 17	36.25	2.32	18.47	0.00	0.00	16.77
		Biotite	Spectrum 18	36.74	2.26	18.59	0.00	0.00	16.48
		Biotite	Spectrum 22	36.73	2.27	18.95	0.00	0.00	16.53
		Garnet Rim*	Spectrum 147	36.40	0.00	21.41	0.00	0.00	33.06
		Garnet Rim	Spectrum 148	36.37	0.00	21.41	0.00	0.00	32.82
		Garnet Rim	Spectrum 149	36.79	0.00	21.30	0.00	0.00	32.98
		Garnet Rim	Spectrum 150	36.46	0.00	21.25	0.00	0.00	32.82
		Garnet Rim	Spectrum 151	37.05	0.00	21.50	0.00	0.00	33.06
		Garnet Rim	Spectrum 152	35.98	0.00	21.23	0.00	0.00	32.64
		Garnet Rim	Spectrum 153	37.00	0.00	21.48	0.00	0.00	32.53
		Garnet Rim	Spectrum 154	36.98	0.00	21.39	0.00	0.00	32.70
		Garnet Rim	Spectrum 155	36.85	0.00	21.91	0.00	0.00	32.57
		Garnet Rim	Spectrum 156	36.85	0.00	21.49	0.00	0.00	32.62
		Garnet Rim	Spectrum 157	36.62	0.00	21.30	0.00	0.00	32.50
		Garnet Rim	Spectrum 158	37.47	0.00	21.79	0.00	0.00	32.19
		Garnet Rim	Spectrum 159	36.89	0.00	21.78	0.00	0.00	32.49
		Garnet Rim	Spectrum 160	36.95	0.00	21.58	0.00	0.00	32.27
		Garnet Rim	Spectrum 161	36.62	0.00	21.26	0.00	0.00	32.23
		Garnet Rim	Spectrum 162	36.98	0.00	21.58	0.00	0.00	32.54
		Garnet Rim	Spectrum 163	36.89	0.00	21.81	0.00	0.00	32.43
		Garnet Rim	Spectrum 164	36.67	0.00	21.67	0.00	0.00	32.00
		Garnet Rim	Spectrum 165	36.93	0.00	21.57	0.00	0.00	32.60
		Garnet Rim	Spectrum 166	36.87	0.00	21.68	0.00	0.00	32.39

MnO	MgO	CaO	Na2O	K2O	Total
0.00	1.64	3.04	0.00	0.00	98.83
0.00	1.69	3.17	0.00	0.00	99.83
0.00	1.61	3.14	0.00	0.00	99.67
0.00	1.68	3.21	0.00	0.00	100.11
0.00	1.66	3.06	0.25	0.00	99.81
0.00	1.63	3.12	0.00	0.00	99.72
0.00	1.65	3.20	0.00	0.00	99.33
0.00	1.61	3.04	0.00	0.00	99.07

MnO	MgO	CaO	Na2O	K2O	ZnO	Total
0.00	2.00	0.00	0.00	0.00	0.00	98.07
0.11	2.02	0.00	0.00	0.00	0.00	98.45
0.00	2.01	0.00	0.00	0.00	0.16	97.98
0.00	2.06	0.00	0.00	0.00	0.00	98.07
0.00	2.02	0.00	0.00	0.00	0.00	97.88

TABLE 7G SCANNING ELECTRON MICROSCOPE ENERGY DISPERSION MICROSCOPY POINT DATA

MnO	MgO	CaO	Na2O	K2O	Total
3.90	5.06	1.53	0.00	0.00	101.58
3.94	5.09	1.59	0.00	0.00	101.76
3.95	5.00	1.58	0.00	0.00	101.94
3.93	4.92	1.53	0.00	0.00	101.30
3.87	4.86	1.55	0.00	0.00	101.44
3.91	5.03	1.53	0.00	0.00	101.48
0.00	0.00	7.85	7.10	0.00	99.71
0.00	0.00	7.91	7.06	0.08	99.97
0.00	0.00	7.91	7.09	0.08	100.35
0.00	0.00	7.96	7.04	0.00	99.90
0.00	12.70	0.00	0.46	8.34	95.31
0.00	12.70	0.11	0.43	8.41	95.72
0.00	12.97	0.12	0.44	8.13	96.15
3.71	3.86	1.47	0.00	0.00	99.90
3.71	3.86	1.44	0.00	0.00	99.61
3.64	4.16	1.52	0.00	0.00	100.39
3.48	4.23	1.51	0.00	0.00	99.74
3.38	4.43	1.42	0.00	0.00	100.83
3.46	4.25	1.57	0.00	0.00	99.12
3.30	4.38	1.51	0.00	0.00	100.20
3.42	4.52	1.48	0.00	0.00	100.48
3.27	4.45	1.57	0.00	0.00	100.61
3.53	4.51	1.47	0.00	0.00	100.47
3.32	4.31	1.41	0.00	0.00	99.46
3.37	4.46	1.43	0.00	0.00	100.72
3.27	4.42	1.47	0.00	0.00	100.32
3.34	4.53	1.49	0.00	0.00	100.15
3.30	4.48	1.46	0.00	0.00	99.34
3.07	4.51	1.53	0.00	0.00	100.21
3.10	4.68	1.46	0.00	0.00	100.36
3.08	4.76	1.47	0.00	0.00	99.64
3.21	4.59	1.50	0.25	0.00	100.65
3.04	4.63	1.50	0.00	0.00	100.12

Sample	Analysis Date	Mineral	Spectrum	SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
		Garnet Rim	Spectrum 167	36.75	0.00	21.44	0.00	0.00	32.19
		Garnet Rim	Spectrum 168	36.86	0.00	21.72	0.00	0.00	32.46
		Garnet Rim	Spectrum 169	37.06	0.00	21.60	0.00	0.00	32.47
		Garnet Rim	Spectrum 172	37.03	0.00	21.60	0.00	0.00	32.25
		Garnet Rim	Spectrum 173	36.68	0.00	21.11	0.00	0.00	32.36
		Garnet Rim	Spectrum 174	36.99	0.00	21.52	0.00	0.00	32.27
		Garnet Rim	Spectrum 175	36.78	0.00	21.46	0.00	0.00	32.13
		Garnet Rim	Spectrum 176	36.99	0.00	21.48	0.00	0.00	32.22
		Garnet Rim	Spectrum 177	37.00	0.00	21.18	0.00	0.00	32.04
		Garnet Rim	Spectrum 178	36.76	0.00	21.72	0.00	0.00	32.06
		Garnet Rim	Spectrum 179	36.97	0.00	21.60	0.00	0.00	32.00
		Garnet Rim	Spectrum 180	37.12	0.00	21.36	0.00	0.00	32.16
		Garnet Rim	Spectrum 181	36.83	0.00	21.31	0.00	0.00	32.10
		Garnet Rim	Spectrum 182	37.06	0.00	21.34	0.00	0.00	32.11
		Garnet Rim	Spectrum 183	36.99	0.00	21.51	0.00	0.00	32.19
		Feldspar	Spectrum 23	58.09	0.00	26.57	0.00	0.00	0.12
		Feldspar	Spectrum 23	58.09	0.00	26.57	0.00	0.00	0.12
		Feldspar	Spectrum 27	58.07	0.00	26.84	0.00	0.00	0.17
		Feldspar	Spectrum 28	58.48	0.00	26.79	0.00	0.00	0.19
		Feldspar	Spectrum 29	58.54	0.00	26.73	0.00	0.00	0.00
		Feldspar	Spectrum 30	58.12	0.00	26.58	0.00	0.00	0.11
		Feldspar	Spectrum 31	58.28	0.00	26.50	0.00	0.00	0.00
		Feldspar	Spectrum 32	58.56	0.00	26.68	0.00	0.00	0.11
		Feldspar	Spectrum 34	57.79	0.00	26.76	0.00	0.00	0.17
		Biotite	Spectrum 36	36.15	3.21	17.75	0.00	0.00	18.15
		Biotite	Spectrum 38	36.13	3.03	17.86	0.00	0.00	18.08
		Biotite	Spectrum 41	37.44	2.99	18.26	0.00	0.00	17.58
		Biotite	Spectrum 45	37.10	3.01	18.17	0.00	0.00	17.36
		Garnet Rim	Spectrum 184	38.73	0.00	22.40	0.00	0.00	32.00
		Garnet Rim	Spectrum 185	36.73	0.00	21.19	0.00	0.00	33.39
		Garnet Rim	Spectrum 186	36.91	0.00	21.60	0.00	0.00	33.38
		Garnet Rim	Spectrum 187	37.16	0.00	21.40	0.00	0.00	32.99
		Garnet Rim	Spectrum 188	37.30	0.00	21.47	0.00	0.00	33.05
		Garnet Rim	Spectrum 189	36.84	0.00	21.64	0.00	0.00	32.77
		Garnet Rim	Spectrum 190	37.10	0.00	21.53	0.00	0.00	32.53
		Garnet Rim	Spectrum 191	36.53	0.00	20.93	0.00	0.00	32.32
		Garnet Rim	Spectrum 192	37.35	0.00	21.56	0.00	0.00	32.70
		Garnet Rim	Spectrum 193	36.71	0.00	21.54	0.00	0.00	32.82
		Garnet Rim	Spectrum 194	42.45	0.00	24.69	0.00	0.00	32.09
		Garnet Rim	Spectrum 195	50.28	0.00	29.53	0.00	0.00	32.34
		Garnet Rim	Spectrum 196	37.57	0.00	21.65	0.00	0.00	32.80
		Garnet Rim	Spectrum 197	37.42	0.00	21.42	0.00	0.00	32.61
		Garnet Rim	Spectrum 198	37.43	0.00	21.69	0.00	0.00	32.66
		Garnet Rim	Spectrum 199	37.02	0.00	21.23	0.00	0.00	31.98
		Garnet Rim	Spectrum 200	36.89	0.00	21.52	0.00	0.00	32.17
		Garnet Rim	Spectrum 201	37.09	0.00	21.63	0.00	0.00	32.22
		Garnet Rim	Spectrum 202	37.12	0.00	21.70	0.00	0.00	32.40
		Garnet Rim	Spectrum 203	37.14	0.00	21.58	0.00	0.00	32.15
		Garnet Rim	Spectrum 204	36.99	0.00	21.70	0.00	0.00	32.01
		Garnet Rim	Spectrum 205	37.05	0.00	21.44	0.00	0.00	32.45

MnO	MgO	CaO	Na2O	K2O	Total
2.93	4.74	1.50	0.00	0.00	99.56
3.13	4.84	1.46	0.00	0.00	100.47
2.95	4.90	1.49	0.00	0.00	100.48
2.94	5.03	1.49	0.00	0.00	100.34
2.84	5.04	1.51	0.00	0.00	99.53
2.80	4.78	1.47	0.00	0.00	99.84
2.96	4.95	1.48	0.00	0.00	99.77
2.80	4.87	1.42	0.00	0.00	99.78
2.81	5.06	1.45	0.00	0.00	99.54
2.84	5.07	1.55	0.00	0.00	99.99
2.83	5.05	1.52	0.00	0.00	99.96
2.80	5.13	1.52	0.00	0.00	100.10
2.95	5.05	1.56	0.00	0.00	99.80
2.83	5.07	1.45	0.00	0.00	99.88
2.85	5.11	1.51	0.00	0.00	100.17
0.00	0.00	8.06	7.00	0.00	99.84
0.00	0.00	8.06	7.00	0.00	99.84
0.00	0.00	8.11	6.91	0.00	100.10
0.00	0.00	8.17	7.04	0.00	100.66
0.00	0.00	7.98	7.01	0.07	100.33
0.00	0.00	7.99	6.85	0.00	99.65
0.00	0.00	7.87	7.02	0.00	99.67
0.00	0.00	7.88	6.63	0.00	99.85
0.00	0.00	8.07	6.79	0.00	99.59
0.12	11.47	0.11	0.40	8.42	95.78
0.00	11.17	0.11	0.41	8.31	95.10
0.00	11.88	0.24	0.48	8.17	97.04
0.00	11.57	0.24	0.46	8.08	95.99
4.67	2.61	1.82	0.24	0.00	102.47
3.96	3.65	1.48	0.00	0.00	100.40
3.57	4.14	1.47	0.00	0.00	101.06
3.24	4.20	1.51	0.00	0.00	100.49
2.93	4.57	1.44	0.00	0.00	100.76
2.92	4.53	1.51	0.00	0.00	100.20
2.75	4.77	1.45	0.00	0.00	100.14
2.82	4.82	1.53	0.00	0.00	98.95
2.71	4.97	1.59	0.00	0.00	100.88
2.60	4.94	1.44	0.00	0.00	100.05
2.58	5.80	1.54	0.00	0.00	109.15
2.57	7.61	1.59	0.00	0.00	123.92
2.63	4.92	1.50	0.00	0.00	101.06
2.46	5.09	1.53	0.00	0.00	100.55
2.56	5.03	1.41	0.00	0.00	100.78
2.51	5.13	1.44	0.00	0.00	99.31
2.60	5.30	1.47	0.00	0.00	99.95
2.54	5.17	1.48	0.00	0.00	100.13
2.64	5.22	1.57	0.00	0.00	100.65
2.45	5.24	1.51	0.00	0.00	100.06
2.52	5.25	1.56	0.00	0.00	100.03
2.41	5.36	1.55	0.00	0.00	100.25

Sample	Analysis Date	Mineral	Spectrum	SiO2	TiO2	Al2O3	Cr2O3	Fe2O3	FeO
		Garnet Rim	Spectrum 206	36.86	0.00	21.50	0.00	0.00	32.10
		Garnet Rim	Spectrum 207	37.22	0.00	21.50	0.00	0.00	32.25
		Garnet Rim	Spectrum 208	37.13	0.00	21.37	0.00	0.00	32.19
		Garnet Rim	Spectrum 209	36.74	0.00	21.43	0.00	0.00	31.96
		Matrix Cordierite	Spectrum 46	47.66	0.00	33.07	0.00	0.00	7.31
		Matrix Cordierite	Spectrum 48	47.29	0.00	33.15	0.00	0.00	7.55
		Matrix Cordierite	Spectrum 49	47.81	0.00	33.75	0.00	0.00	7.57
		Matrix Cordierite	Spectrum 50	47.56	0.00	33.57	0.00	0.00	7.60
		Matrix Cordierite	Spectrum 51	47.59	0.00	33.40	0.00	0.00	7.67
		Matrix Cordierite	Spectrum 52	47.72	0.00	33.39	0.00	0.00	7.69
		Matrix Cordierite	Spectrum 53	47.73	0.00	33.17	0.00	0.00	7.55
		Matrix Cordierite	Spectrum 54	47.64	0.00	33.53	0.00	0.00	7.63
		Matrix Cordierite	Spectrum 55	48.07	0.00	33.68	0.00	0.00	7.61
		Matrix Cordierite	Spectrum 56	48.41	0.00	34.05	0.00	0.00	7.72
		Matrix Cordierite	Spectrum 57	47.73	0.00	33.30	0.00	0.00	7.61
		Matrix Cordierite	Spectrum 58	47.65	0.00	33.29	0.00	0.00	7.60
		Matrix Cordierite	Spectrum 59	47.65	0.00	33.41	0.00	0.00	7.72
		Matrix Cordierite	Spectrum 60	47.67	0.00	33.39	0.00	0.00	7.61
		Matrix Cordierite	Spectrum 61	47.39	0.00	33.34	0.00	0.00	7.56
		S1 Cordierite	Spectrum 71	47.43	0.00	33.10	0.00	0.00	7.55
		S1 Cordierite	Spectrum 72	47.78	0.00	33.61	0.00	0.00	7.55
		S1 Cordierite*	Spectrum 73	47.55	0.00	33.32	0.00	0.00	7.56
		S1 Cordierite	Spectrum 74	47.67	0.00	33.24	0.00	0.00	7.49
		S1 Cordierite	Spectrum 75	47.48	0.00	33.42	0.00	0.00	7.52
		S1 Cordierite	Spectrum 76	47.54	0.00	33.38	0.00	0.00	7.38
		S1 Cordierite	Spectrum 77	47.53	0.00	33.23	0.00	0.00	7.50
		S1 Cordierite	Spectrum 78	47.50	0.00	33.11	0.00	0.00	7.49
		Biotite in Cordierite	Spectrum 79	36.89	2.79	18.38	0.00	0.00	17.87
		Biotite in Cordierite	Spectrum 80	36.96	2.86	18.56	0.00	0.00	17.97
		Biotite in Cordierite	Spectrum 81	35.47	2.76	18.15	0.00	0.00	18.00
		Biotite in Cordierite*	Spectrum 82	36.91	2.77	18.70	0.00	0.00	17.95
		Biotite in Cordierite	Spectrum 83	36.36	2.78	18.45	0.00	0.00	17.99
		Biotite in Cordierite	Spectrum 84	36.60	2.75	18.43	0.00	0.00	18.10
		Biotite in Cordierite	Spectrum 85	35.74	2.76	17.70	0.00	0.00	17.65
		Biotite in Cordierite	Spectrum 86	36.60	2.51	19.65	0.00	0.00	16.34
		Biotite in Cordierite	Spectrum 87	36.33	2.68	18.50	0.00	0.00	18.02
		Biotite in Cordierite	Spectrum 88	37.02	2.81	18.58	0.00	0.00	18.10
		Biotite in Cordierite	Spectrum 89	34.48	2.73	17.28	0.00	0.00	17.73
		Biotite in Cordierite	Spectrum 90	36.30	2.74	18.38	0.00	0.00	17.86
		Biotite in Cordierite	Spectrum 91	36.60	2.82	18.31	0.00	0.00	17.91
		Biotite in Cordierite	Spectrum 92	38.36	2.78	19.32	0.00	0.00	17.83
		Biotite in Cordierite	Spectrum 93	37.45	2.74	18.99	0.00	0.00	17.98

*analysis used for pressure and temperature calculation

MnO	MgO	CaO	Na2O	K2O	Total
2.52	5.26	1.56	0.00	0.00	99.79
2.48	5.30	1.61	0.00	0.00	100.36
2.43	5.18	1.56	0.00	0.00	99.86
2.51	5.24	1.50	0.00	0.00	99.37
0.25	8.57	0.33	0.33	0.00	97.53
0.23	8.73	0.00	0.33	0.00	97.28
0.23	8.89	0.00	0.40	0.00	98.66
0.19	8.72	0.00	0.37	0.00	98.01
0.23	8.86	0.00	0.38	0.00	98.12
0.20	8.84	0.00	0.31	0.00	98.15
0.21	8.74	0.00	0.37	0.00	97.77
0.17	8.75	0.00	0.32	0.00	98.04
0.22	8.81	0.00	0.32	0.00	98.72
0.20	8.96	0.00	0.35	0.00	99.68
0.21	8.61	0.00	0.37	0.00	97.84
0.20	8.67	0.00	0.32	0.00	97.73
0.22	8.78	0.00	0.34	0.00	98.13
0.21	8.64	0.00	0.34	0.00	97.86
0.19	8.71	0.00	0.39	0.00	97.59
0.26	8.76	0.00	0.39	0.00	97.48
0.21	8.81	0.00	0.39	0.00	98.36
0.28	8.82	0.00	0.41	0.00	97.95
0.23	8.71	0.00	0.42	0.00	97.77
0.23	8.71	0.00	0.33	0.00	97.69
0.23	8.77	0.00	0.36	0.00	97.66
0.21	8.65	0.00	0.35	0.00	97.48
0.20	8.73	0.00	0.40	0.00	97.43
0.11	11.43	0.00	0.42	8.49	96.39
0.11	11.55	0.15	0.45	8.57	97.18
0.11	10.95	0.00	0.39	8.35	94.17
0.00	11.42	0.00	0.40	8.58	96.74
0.00	11.26	0.00	0.47	8.50	95.82
0.00	11.40	0.00	0.42	8.52	96.21
0.14	10.99	0.18	0.35	8.12	93.65
0.00	9.90	0.10	0.40	7.42	92.92
0.00	11.38	0.00	0.40	8.27	95.59
0.00	11.57	0.00	0.40	8.51	97.00
0.00	10.56	0.00	0.41	8.44	91.64
0.00	11.42	0.00	0.41	8.26	95.38
0.00	11.41	0.00	0.40	8.43	95.89
0.13	11.86	0.16	0.44	8.52	99.40
0.00	11.59	0.00	0.38	8.47	97.59

TABLE 8 PHOSPHATE CORRECTED X-RAY FLUORESCENCE BULK ROCK DATA

	191-03A	191-05A	191-08A	191-10a	191-11	191-17A	191-17B	191-21A	191-22A	191-28A	191-30	191-34
Unnormalized Major Elements (Weight %):												
SiO2	68.264	65.706	71.920	54.780	67.371	59.796	65.285	61.648	57.881	63.284	63.766	67.177
TiO2	0.705	0.786	0.613	0.961	0.691	0.992	0.744	0.791	1.047	0.814	0.849	0.721
Al2O3	13.305	14.521	14.309	20.375	14.165	19.072	15.594	17.703	20.459	16.311	16.796	15.019
FeO*	5.803	5.958	4.710	7.078	5.206	7.314	5.630	6.070	7.120	6.033	6.641	5.343
MnO	0.096	0.082	0.086	0.082	0.087	0.092	0.116	0.092	0.076	0.144	0.095	0.062
MgO	2.556	2.968	2.027	3.013	2.483	3.510	2.427	2.838	3.246	2.644	2.679	2.483
CaO	2.397	3.235	0.801	3.604	1.911	1.465	1.265	2.223	1.607	2.225	1.635	1.943
Na2O	1.981	2.215	1.251	3.726	2.339	2.237	2.803	2.919	2.310	2.480	1.995	2.184
K2O	1.978	1.453	1.590	2.064	1.838	3.151	1.986	2.293	2.635	2.136	1.957	1.888
Sum	97.085	96.924	97.308	95.683	96.090	97.629	95.849	96.577	96.380	96.071	96.413	96.820
LOI %	1.525	1.701	1.663	2.636	3.024	1.678	2.410	1.927	2.331	2.538	2.394	2.275
Total	98.610	98.625	98.972	98.320	99.114	99.306	98.259	98.505	98.711	98.609	98.807	99.095

All samples were adjusted to remove phorphorous using the calculation (CaO concentration - (3.33/P2O5 concentration))

TABLE 8 PHOSPHATE CORRECTED X-RAY FLUORESCENCE BULK ROCK DATA

	191-36	191-41	191-46B	191-46c	191-47B
Unnormalized Major Elements (Weight %):					
SiO2	63.360	66.003	61.898	60.497	59.420
TiO2	0.839	0.789	0.834	0.859	0.940
Al2O3	18.139	15.469	16.973	17.129	18.474
FeO*	6.484	6.255	7.087	7.504	6.289
MnO	0.120	0.072	0.116	0.154	0.078
MgO	2.623	3.165	3.551	3.685	2.879
CaO	1.420	1.197	1.976	2.538	2.398
Na2O	1.491	1.352	2.245	2.688	3.396
K2O	2.534	1.809	1.973	2.403	2.154
Sum	97.011	96.110	96.654	97.457	96.028
LOI %	2.408	2.426	1.961	1.268	2.289
Total	99.419	98.537	98.615	98.725	98.317

All samples were adjusted to remove phorphorous using the calculation (CaO concentration - (3.33/P2O5 concentration))

TABLE 9 LU-HF ISOTOPIC DATA

Sample:	Lu (ppm)	Hf (ppm)	176Lu/176Hf	176Hf/177Hf	±	εHf (present)	εHf (initial)	±
191-05a [93.11±3.4, MSWD=9]								
WRS	0.11	1.24	0.01256	0.282865	14	2.82	4.11	0.11
WRB	0.21	5.01	0.00590	0.282813	14	1.00	2.71	0.10
G1†	7.58	0.46	2.36347	0.287877	15	180.07	N.A.	N.A.
G2†	10.26	0.59	2.44570	0.287635	15	171.51	N.A.	N.A.
G3†	8.24	0.58	2.00241	0.287449	15	164.93	N.A.	N.A.
G4†	11.85	0.65	2.58313	0.287584	15	169.72	N.A.	N.A.
G5	12.58	0.89	2.01679	0.286323	15	125.13	3.11	0.17
G6†	12.15	0.86	2.012639	0.286313	15	124.76	N.A.	N.A.
G7†	11.98	0.99	1.714354	0.285749	15	104.83	N.A.	N.A.
G8†	12.00	1.00	1.70687	0.285744	15	104.64	N.A.	N.A.
G9	12.00	1.00	1.70487	0.285798	15	106.56	3.73	0.09
191-08a [94.1±5.6, MSWD=38]								
WRS	0.28	1.29	0.03102	0.282874	14	3.14	3.3	0.11
WRB	0.31	4.36	0.01008	0.282768	14	-0.60	0.86	0.10
G1	8.93	0.19	6.66654	0.294036	17	397.86	-14.59	0.27
G2	10.09	0.13	10.94261	0.302115	18	683.57	5.23	0.36
G3	8.39	0.16	7.24366	0.295941	18	465.24	16.92	0.34
G4†	10.80	0.13	11.43211	0.317492	27	1227.32	N.A.	N.A.
191-10a [90.1±5.3, MSWD=3.3]								
WRS	0.14	2.79	0.00734	0.282793	14	0.29	1.85	0.11
WRB	0.02	0.56	0.00408	0.282708	28	-2.72	-0.97	0.11
G1	9.28	1.22	1.08101	0.28448	30	59.94	-2.42	0.30
G2	9.74	1.04	1.32451	0.285016	29	78.88	2.03	0.16
G3	9.20	1.02	1.28554	0.284901	29	74.82	0.29	0.21
G4	8.91	0.98	1.28859	0.284912	29	75.20	0.49	0.26
191-17b [118.7±5, MSWD=4.2]								
WRS	0.20	1.06	0.02627	0.282842	15	2.01	2.58	0.13
WRB†	0.23	3.91	0.00846	0.282689	15	-3.38	-1.41	0.12
G1	6.90	0.44	2.20818	0.287755	29	175.13	5.13	0.14
G2	8.47	0.45	2.68081	0.288756	29	221.13	3.45	0.14
G3†	6.96	0.40	2.46283	0.289149		225.03	N.A.	N.A.
G4	9.72	0.44	3.13186	0.289637	29	242.29	-0.78	0.13

Sample:	Lu (ppm)	Hf (ppm)	176Lu/176Hf	176Hf/177Hf	±	εHf (present)	εHf (initial)	±
191-22a [90.2±3.3, MSWD=7.8]								
WRS†	0.07	1.21	0.00828	0.282779	15	-0.23	1.28	0.13
WRB	0.67	6.33	0.01500	0.282717	26	-2.41	-1.3	0.76
G1	11.47	0.13	12.85565	0.304316	19	761.38	-2.84	0.39
G2	13.90	0.14	13.78765	0.306385	17	834.55	14.79	0.30
G3†	13.85	0.14	14.32959	0.308266	19	901.07	N.A.	N.A.
G4	16.12	0.15	15.19854	0.308124	16	896.05	-7.81	0.21
191-36 [103±4.7, MSWD=7.8]								
WRS	0.23	0.50	0.06390	0.282734	29	-1.81	-3.87	0.20
WRB	0.23	3.27	0.00996	0.282789	28	0.13	1.74	0.10
G1†	9.67	0.12	11.12810	0.302254	31	688.47	N.A.	N.A.
G2†	7.12	0.11	9.59191	0.304538	32	769.26	N.A.	N.A.
G3	9.22	0.11	11.63976	0.305077	32	788.29	-1.72	0.33
G4	9.40	0.11	11.97176	0.305781	31	813.20	0.59	0.15
G5†	8.67	0.11	11.08772	0.303448	16	730.69	N.A.	N.A.
G6†	8.51	0.12	10.52517	0.303781	16	742.46	N.A.	N.A.
191-46c [93.2±3.6, MSWD=23]								
WRS	0.60	1.00	0.08590	0.283076	15	10.29	7.07	0.17
WRB	0.40	3.44	0.01640	0.282869	14	2.96	4.02	0.11
G1†	5.14	0.27	2.68907	0.289571	17	239.98	N.A.	N.A.
G2†	9.37	0.31	4.24225	0.290515	17	273.36	N.A.	N.A.
G3†	6.88	0.29	3.38294	0.290446	16	270.93	N.A.	N.A.
G4†	6.27	0.24	3.74199	0.290558	18	274.87	N.A.	N.A.
G5	9.80	0.38	3.70619	0.289207	15	227.09	0.91	0.11
G6	10.03	0.35	4.07637	0.290027	15	256.09	7.11	0.12
G7	10.29	0.38	3.84097	0.289519	15	238.14	3.66	0.13

†=separate excluded from age calculation

TABLE 10 SM-ND ISOTOPIC DATA

Sample:	Sm (ppm)	Nd (ppm)	147Sm/144Nd	143Nd/144Nd	±	εNd (present)	εNd (initial)	±
191-05a [106.2±22, MSWD=3.4]								
WRS	5.21	23.74	0.13271	0.512528	15	-1.99	-1.14	0.19
WRB	5.62	25.72	0.13205	0.512522	14	-2.11	-1.24	0.15
G1	1.87	3.99	0.34385	0.512682	13	1.01	-0.99	0.12
G2	2.51	6.06	0.25085	0.512604	13	-0.51	-1.25	0.09
G3	1.65	2.9	0.28315	0.512640	13	0.2	-0.98	0.09
G4	2.70	5.54	0.29505	0.512652	13	0.43	-0.91	0.10
G5	6.38	22.51	0.17142	0.512582	14	-0.93	-0.6	0.12
191-08a [86±14, MSWD=0.12]								
WRS	0.93	4.55	0.12431	0.512462	15	-3.27	-2.48	0.17
WRB	6.23	30.14	0.12504	0.512463	15	-3.25	-2.47	0.19
G1	1.01	2.67	0.22845	0.512525	12	-2.05	-2.41	0.01
G2	0.84	1.94	0.26135	0.512540	14	-1.76	-2.48	0.14
G3	0.83	1.88	0.26572	0.512540	14	-1.76	-2.53	0.16
G4	0.80	1.72	0.27997	0.512552	15	-1.52	-2.44	0.16
191-10a [95±10, MSWD=1.08]								
WRS	1.59	0.63	0.11794	0.512393	14	-4.62	-3.67	0.16
WRB	1.69	0.66	0.11742	0.512389	16	-4.71	-3.75	0.20
G1	1.74	0.62	0.30066	0.512528	15	-2	-3.27	0.17
G2	1.83	0.56	0.26873	0.512504	15	-2.46	-3.35	0.17
G3	2.14	0.64	0.27680	0.512517	14	-2.21	-3.19	0.15
G4	2.27	0.64	0.60634	0.512696	15	1.29	-3.75	0.16
191-17b [88.3±3.3, MSWD=1.8]								
WRS	0.85	4.13	0.12439	0.512460	16	-3.31	-2.5	0.15
WRB	3.38	16	0.12785	0.512485	17	-2.83	-2.06	0.19
G1	1.82	1.38	0.79702	0.512858	14	4.45	-2.32	0.12
G2	2.27	2.07	0.66301	0.512788	13	308	-2.19	0.10
G3	1.72	2.09	0.49851	0.512675	13	0.89	-2.52	0.12
G4	1.96	1.54	0.77125	0.512841	13	4.11	-2.37	0.11
191-22a [89.5±3, MSWD=1.1]								
WRS	6.61	34.31	0.11644	0.512432	16	-3.86	-2.96	0.23
WRB	6.79	35.43	0.11596	0.512423	18	-4.03	-3.12	0.15
G1	0.98	0.62	0.96787	0.512898	16	5.24	-3.58	0.15
G2	1.14	1.69	0.40755	0.512588	18	-0.82	-3.24	0.21
G3	0.89	0.31	1.72182	0.513373	17	14.5	-2.93	0.19
G4	1.00	0.97	0.62660	0.512711	18	1.57	-3.35	0.21

Sample:	Sm (ppm)	Nd (ppm)	147Sm/144Nd	143Nd/144Nd	±	εNd (present)	εNd (initial)	±
191-36 [91.1±2.3, MSWD=1.5]								
WRS	3.38	16.69	0.12246	0.512528	16	-1.98	-1.13	0.15
WRB	3.77	17.18	0.13276	0.512521	18	-2.13	-1.39	0.21
G1	2.70	1.64	0.99687	0.513043	14	8.06	-1.25	0.12
G2†	1.14	0.69	0.99853	0.512992	12	7.05	N.A.	N.A.
G3	1.82	1.11	0.99469	0.513031	14	7.82	-1.46	0.13
G4	1.92	1.00	1.16113	0.513147	14	10.09	-1.13	0.13
191-46c [90±21, MSWD=0.69]								
WRS†	4.07	17.23	0.14292	0.512597	16	-1.08	-0.34	0.19
WRB	0.61	2.82	0.13187	0.512575	17	-0.64	-0.03	0.16
G1	2.05	5.05	0.24510	0.512634	13	0.07	-0.49	0.09
G2	3.60	8.84	0.24600	0.512647	13	0.33	-0.24	0.10
G3	2.06	4.88	0.25537	0.512648	13	0.35	-0.33	0.11
G4	1.95	4.23	0.27833	0.512662	13	0.62	-0.33	0.09

†=separate excluded from age calculation

TABLE 11A NEW AND EXISTING GEOCHRONOLGY SUMMARY (METAMORPHIC)

Publication	Mineral	Age (Ma)	Error (+/-)	Pres	Error (+/-)	
Baker et al. 2016	Garnet (Lu-Hf)	92.5	1.6	2.9	1.2	
Baker et al. 2017	Garnet (Lu-Hf)	92.6	3.3	4.5	1.1	
Baker et al. 2018	Garnet (Lu-Hf)	90.3	2.3	6.3	1.5	
Baker et al. 2018	Garnet (Lu-Hf)	94	5	5.5	1	
Baker et al. 2018	Garnet (Lu-Hf)	88.9	4.7	4.2	1.7	
Baker et al. 2018	Garnet (Lu-Hf)	118.7	5	4	1	
Baker et al. 2018	Garnet (Lu-Hf)	103.5	4.7	4	1	
Baker et al. 2018	Garnet (Sm-Nd)	110.7	19	3	1	
Baker et al. 2018	Garnet (Sm-Nd)	86	14	7.1	0.8	
Baker et al. 2018	Garnet (Sm-Nd)	95	10	4.2	1.7	
Baker et al. 2018	Garnet (Sm-Nd)	88.3	3.3	5.9	2.2	
Baker et al. 2018	Garnet (Sm-Nd)	89.5	3	6.3	1.5	
Baker et al. 2018	Garnet (Sm-Nd)	91.1	2.3	7.4	1.1	
Baker et al. 2018	Garnet (Sm-Nd)	90	21	4.5	1.1	
Magloughlin and edwards,	Garnet (Sm-Nd)	89	2	7		No pressure data
Magloughlin and edwards,	Garnet (Sm-Nd)	103	5	3		No pressure data
Magloughlin and edwards,	Garnet (Sm-Nd)	118	15	3		No pressure data
Magloughlin and edwards,	Garnet (Sm-Nd)	91		5	1.5	No pressure data
Magloughlin and edwards,	Garnet (Sm-Nd)	91		5	1.5	No pressure data
Magloughlin and edwards,	Garnet (Sm-Nd)	92		5	1.5	No pressure data
Magloughlin and edwards,	Garnet (Sm-Nd)	92		5	1.5	No pressure data
Chase, 1998 (Unpublished)	Garnet (Sm-Nd)	125	18	3		No pressure data
Stowell and Tinkham, 2003	Garnet (Sm-Nd)	86	1	6	1	
Stowell and Tinkham, 2003	Garnet (Sm-Nd)	86.1	0.6	6	1	
Stowell et al. 2011	Garnet (Sm-Nd)	90.2	1.5	6.9	1	
Stowell et al. 2011	Garnet (Sm-Nd)	90.1	1.5	7	1	
Stowell et al. (Unpublished)	Garnet (Sm-Nd)	86	1	6		No pressure data
Stowell et al. (Unpublished)	Garnet (Sm-Nd)	88	2	6		No pressure data
Stowell et al. (Unpublished)	Garnet (Sm-Nd)	86.4	1.9	6		No pressure data
Stowell et al. (Unpublished)	Garnet (Sm-Nd)	88.7	0.7	5		No pressure data
Stowell et al. (Unpublished)	Garnet (Sm-Nd)	88.4	2.9	6		No pressure data
Holler, 2013	Garnet (Sm-Nd)	133	18	9	1.5	
Holler, 2013	Garnet (Sm-Nd)	104.8	8.9	9	1.5	
Evans and Davidson, 1999	Hornblende (Ar-Ar)	86.7	1.5			
Evans and Davidson, 1999	Hornblende (Ar-Ar)	87.5	0.2			
Evans and Davidson, 1999	Hornblende (Ar-Ar)	85	0.4			
Evans and Davidson, 1999	Muscovite (Ar-Ar)	82	1			
Evans and Davidson, 1999	Muscovite (Ar-Ar)	80.6	0.2			
Evans and Davidson, 1999	Biotite (Ar-Ar)	83.7	0.3			
Evans and Davidson, 1999	Biotite (Ar-Ar)	86.3	1.1			
Evans and Davidson, 1999	Biotite (Ar-Ar)	84.8	0.1			
Evans and Davidson, 1999	Biotite (Ar-Ar)	85.2	0.7			
Evans and Davidson, 1999	Biotite (Ar-Ar)	78.3	2.5			
Evans and Davidson, 1999	Biotite (Ar-Ar)	77.9	0.4			
Engals and Crowder, 1971	Biotite (K-Ar)	84.6	2.5			

TABLE 11B NEW AND EXISTING GEOCHRONOLGY SUMMARY (IGNEOUS)

Publication	Mineral	Age (Ma)	Error (+/-)	Igneous Body
Yeates and Engals, 1971	Hornblende (K-Ar)	92.1	2.7	Beckler Peak Pluton
Yeates and Engals, 1971	Hornblende (K-Ar)	95	3.3	Mount Stuart Batholith
Engles and Crowder, 1971	Hornblende (K-Ar)	90	2.7	Mount Stuart Batholith
Engles and Crowder, 1971	Hornblende (K-Ar)	90	2.9	Mount Stuart Batholith
Tabor et al., 1993	Hornblende (K-Ar)	87.5	3	Mount Stuart Batholith
Engles and Crowder, 1971	Hornblende (K-Ar)	93.2	3.1	Mount Stuart Batholith
Evans and Davidson, 1999	Hornblende (Ar-Ar)	89.3	0.5	Mount Stuart Batholith
Engles and Crowder, 1971	Biotite (K-Ar)	93.2	2.8	Beckler Peak Pluton
Yeates and Engals, 1971	Biotite (K-Ar)	82.3	5	Beckler Peak Pluton
Yeates and Engals, 1971	Biotite (K-Ar)	92.1	2.7	Beckler Peak Pluton
Engles and Crowder, 1971	Biotite (K-Ar)	90	2.6	Mount Stuart Batholith
Yeates and Engals, 1971	Biotite (K-Ar)	82.3	2.4	Mount Stuart Batholith
Tabor et al., 1993	Biotite (K-Ar)	82.4	1.3	Mount Stuart Batholith
Engles and Crowder, 1971	Biotite (K-Ar)	87.7	2.6	Mount Stuart Batholith
Tabor et al., 1993	Biotite (K-Ar)	87.7	0.2	Mount Stuart Batholith
Tabor et al., 1987	Biotite (K-Ar)	85.3	1.4	Mount Stuart Batholith
Engles and Crowder, 1971	Biotite (K-Ar)	87.7	2.6	Mount Stuart Batholith
Evans and Davidson, 1999	Biotite (Ar-Ar)	87.6	2	Mount Stuart Batholith